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Lost in the Briar Patch 68

Star Trek: Insurrection, the ninth feature film in the venerable science fiction franchise - with veteran cast member Jonathan Frakes again at the helm - had many familiar elements, including prosthetic makeup effects by Michael Westmore, but employed new technologies and new companies in the creation of its abundant visual effects. Santa Barbara Studios crafted spaceship shots entirely in the digital realm - a first for the series - while Blue Sky/WFX contributed a range of predominantly planet-bound illusions. *Article by Kevin H. Martin.*

Thoroughly Modern Mummy 100

For his remake of the Boris Karloff horror classic, *The Mummy*, director Stephen Sommers was determined to present a title character far apart from the bandage-wrapped mummies that lumbered through a variety of decades-old predecessors. Engaged to design and create the mummy Imhotep as both an all-CG character and a digitally altered live actor, plus devise a host of other fabrications involving fearsome sandstorms and plaques, was visual effects supervisor John Berton and the artists at Industrial Light & Magic. *Article by Estelle Shay.*

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COVER - An irked alien nearly gives himself away in *My Favorite Martian*.

MARTIAN CHRONICLES

ARTICLE BY Kevin H. Martin



The rage to transform baby-boomer-era television properties into feature films continues unabated. The sixties, in particular, appear to be a gold mine for such product- witness *Lost in Space*, *McHale's Navy* and *Star Trek*, with *The Wild, Wild West* soon to follow. Ironically, other sixties shows such as *Have Gun, Will Travel* and *The Man From U.N.C.L.E.*, have been mired in development hell for periods of time far outlasting their original network runs.

While *My Favorite Martian*, another sixties-era series, was never a tremendous ratings hit, the lightweight sitcom still managed to create a warm spot in the hearts of many viewers during its three years on CBS. The premise was simple: a Martian (Ray Walston) crash-lands on earth and must masquerade as human while trying to repair his spaceship for the return home. Each week, a stressed and high-strung earthling, Tim O'Hara (Bill Bixby), struggled to keep his alien houseguest- whom he passes off as his 'Uncle Martin'- from being exposed to the world, fending off inquiries from a prying landlady, snoopy neighbors and an ever-inquisitive police detective.

In 1996, Buena Vista Pictures and Uncle Martin Productions joined forces to bring that charmingly simple premise to the big screen. Producers Robert Shapiro and Jerry Leider were in agreement with director Donald Petrie's approach to tackling the project, which retained the two main characters while also adding new elements made possible by a feature film budget and modern technology. "We all wanted to bring *My Favorite Martian* into the nineties," Shapiro said, "but in the process of achieving that goal we didn't want to lose the sense of humanity that made the original so appealing. To that end, we chose effects houses with histories in performance animation to ensure that a sense of personality came through in the work." Two principal providers were brought aboard to accomplish the visual effects: Available Light for digital cars, spacecraft and a variety of animated embellishments, and Tippett Studio for CG character animation. In addition to these two facilities, Rainmaker Digital Pictures, Hammerhead, 4-Ward Productions, Station X Studios, Amalgamated Dynamics, Illusion Arts, Buena Vista Imaging and Dream Quest Images provided key effects, both digital and practical, throughout the film's production and postproduction phases.

Visual effects producer Susan MacLeod was also hired by the production, to put an overall plan in place for the effects during the film's initial design phase, while illustrators Len Morganti and Daren Dochterman worked on conceptual elements. "For the first six weeks there was just Donald Petrie, the producers, myself and a few others at the Santa Monica production offices," Morganti recollected. "The first principal objective was determining the Martian's true form. Originally this wasn't going to be revealed until the very end of the picture- an idea that changed as we went along- but since his appearance was such an important story point, Donald wanted it nailed down. He was very specific in his insistence that the creature not appear horrific. Another concern expressed at this time was that it resemble something toymakers might be interested in manufacturing."

During this initial period, Morganti worked exclusively on visualizing the Martian, his spacesuit and his ship. The illustrator's approach to the ship- which paid homage to the original TV series with a souped-up version of that craft- ultimately fell prey to an art department redesign. By that point in preproduction, the storyboarding process had begun in earnest- and it would go on and on. "A lot of story changes crept in," Morganti explained, "causing scenes to be redrawn and redrawn. We'd come back and find out that what had been a ten- to fifteen-minute sequence was now winnowed down to about two minutes."

Many effects scenes that had been winnowed down in preproduction were later reexpanded as a sign of Disney's pleasure with the film's progress. "The word I got was, 'Hey, make it bigger!'" director Donald Petrie remarked. "I told them that making it bigger was going to cost more- for what they wanted it would take another four million. And they said, 'Great- do it for three million!' They squeezed every dollar onto the screen."

John Van Vliet of Available Light was among the first vendors contacted, and he was quick to commit himself and his company to the picture. "This was My Favorite Martian, a favorite of mine from the past," Van Vliet admitted. "The show was also appealing to me because I got a really good hit off the people involved, especially Donald Petrie. My principal focus related to technical considerations, whereas Donald came from an acting and comedy background. These differences could have proved problematic; but instead we developed a really good dialogue that permitted the work processes to be divvied up accordingly. Unlike a lot of directors, Donald was reasonable, and even followed the storyboards. He'd ask about an effect; and if you came back with, 'Absolutely not; it'll cost ten Cadillacs,' he'd listen. It all really clicked- I only wish the rest of the shows that I've been on worked out as well and as smoothly." Petrie considered assigning the entire effects slate to Available Light, but that notion was discarded when Van Vliet himself suggested that another company- specifically, Tippett Studio- would be better suited to fulfilling the film's character animation needs.

To get the ball rolling, Van Vliet participated in a series of 'brain-pick' meetings that stretched out over the preproduction period. "They started talking to us about the project in March 1997," Van Vliet recalled, "with our official start date being July 10 and live-action starting on July 20. So we had just those ten days to prep the show." For the next three months, Van Vliet engineered the various shots, returning to his office each night after the day's shooting to execute the necessary effects storyboards for the next day. "There was no sleep during that

period– I was just trying to stay ahead of what they were shooting. The boards had to be ready so that everyone on set would know what was needed, effects-wise.”

The film begins with a minute-long teaser– a late addition that was developed as a trailer concept by Intralink before being passed on to Dream Quest Images. An unmanned Sojourner-style space probe is seen traversing the red Martian surface. Views of the ungainly little vessel alternate with POV shots taken from its onboard camera as it cruises along. The probe maneuvers toward a rock; but as it begins a series of tests, the craft’s batteries die. A camera boom-up reveals what lies behind the rock and just beyond the little explorer’s field of view– an elaborate and magical city that owes more to The Jetsons than to Total Recall, Dream Quest’s previous Martian odyssey. The sequence required DQ to construct a landscape model of the Martian surface and a remote-controlled rover that could be driven through it, then to add the distant Martian city via digital matte painting.

After production provided a fairly comprehensive animatic to DQ supervisor Tim Landry and producer David McCullough, artist and frequent DQ collaborator Matt Suzuki was hired to draft up versions of the Mars probe. Once the design was approved by the filmmakers, DQ worked with Petrie and Shapiro to determine particulars on the craft, such as the movement of its ‘waldo’-style control arms, the positioning of real solar panels and provisions for a working suspension system. “Motors were installed within the front tires,” model shop foreman Tony Meininger explained, “allowing the rover to function through a direct drive like the real probe, without a transmission system. This worked out well for the suspension, since we were shooting real-time motion control and wanted a realistic bouncing movement. The control arms worked on remote control through a single axis– and for the POV shots, which included views of the arms working out front, we just puppeteered them off-camera from below.”



In adapting the old television series, *My Favorite Martian*, for the big screen, director Donald Petrie relied heavily on visual effects. An opening scene on Mars involved miniature work and a fanciful matte painting by Dream Quest.

The Martian surface- covered with brick dust to simulate the planet's reddish tones- measured thirty by sixty feet. A 19-by-125-foot painted cyclorama, created by Sky Drops, wrapped around the back and one side of the set. To incorporate the matte painting of the Martian city, a greenscreen was slipped in front of a portion of the backing for the boom-up reveal at the end of the sequence. Computer previsualizations aided in designing the landscape. "Our studies on the boom-up," noted Tim Landry, "revealed that shooting with a wide-angle wouldn't work as well as a longer lens, since we'd have overshot the greenscreen, revealing the cyc backing. That was one of the true strengths of our previz- getting the timings and approaches locked down so there wouldn't be a lot of unnecessary time spent on stage."

The Martian city was a true collaborative effect, originating with a painting supplied by artist Bob Scifo, then undergoing modification by DQ visual designer Jeff Burks and art director Mike Meaker. "Bob's initial inspirations were enhanced by Jeff's interpretations and Mike's details," Landry stated. "The mindset that drove the creation of the Martian city came from Dr. Seuss, of all things. These looping strands and podlike structures gave the city a sense of fun that differed from the usual foreboding gothic approach." To allow for flexibility in lighting and create an enhanced sense of reality, most of the city painting was 3-D. "I prefer to create matte paintings in 3-D or from existing photographs. That way we do as little painting as possible, and whatever we put in will be more photorealistic. Much of the city and its traffic patterns used pieces and layers cobbled together from a dozen different software programs, some 3-D and some 2-D. Our flexibility in this matter allowed our artists to utilize the tools with which they were most familiar."

A spaceship, outward bound from the Martian city, makes its way towards camera, bobbing and weaving unsteadily before crashing through the film's main title card. Dream Quest created an animated exhaust trail and composited the vessel- a digital model built and lit by Available Light, and based on production designer Sandy Veneziano's life-sized creation. "Since the main unit began shooting prior to the full-scale ship's completion - they were still spraying foam on it and sculpting- we initially didn't have a one-hundred-percent-reliable reference," Van Vliet said, "and as a result had to reverse-engineer the craft to figure out how all the pieces went together. Ultimately, a lot of



Animating in the digital realm, Available Light created scenes of a Martian spaceship crash-landing on earth.



Tim O'Hara (Jeff Daniels) swings a golf club at the now-miniaturized spaceship he has found and brought home, only to find that it is being carried by an invisible Martian (Christopher Lloyd) who materializes when struck in the head. Available Light's signature electrical effects- hand-drawn,

additional 3-D construction was needed before we could start animating the ship scenes." Though it would have been preferable for a studio

then scanned and composited over the plate photography- were given a workout in the film.

photographer to shoot stills of the full-size model to create the proper texture maps, the only reference photos Van Vliet was able to get were snapshots grabbed on the run in a studio parking lot.

Bill Arance headed up Available Light's model-ing and animation of the ship, using LightWave 3-D. While LightWave has been a successful previz tool for feature films, the system is best recognized for its scene simulation work on television where it has been successfully exploited by Foundation Imaging for *Hypernauts* and *Babylon 5*. But it has seen only limited full-screen utilization in theatrical motion pictures- perhaps most notably in the opening shot of the *Lost in Space* movie. "LightWave is sort of a low-tech approach," Van Vliet admitted. "In fact, there's a feeling that it can't be used for full resolution- but we did it throughout. Fortunately, Bill Arance is one of the best 3-D model builders and animators I've ever seen. To give the spaceship more life, he fully articulated the legs, then added retracting doors. The legs were like duck feet in water, hanging free and moving slowly." Arance added various circuitry and texturing to the interior of the landing gear bays, plus a Harrier-style heat ripple suggested by Donald Petrie.

A story point establishes that the spaceship- piloted by a Martian anthropologist (Christopher Lloyd) bound for earth- is a rental vehicle; but, judging by its flight performance, the vessel is clearly of a Rent-A-Wreck type. The ship gives up the ghost just prior to making planetfall on earth, skidding and bouncing wildly during an extended crash-landing. "I knew from the nature of Christopher Lloyd's past performances that he can be both subtle and over-the-top at the same time," Van Vliet remarked, "so it was an easy conclusion to make that Martin would do a showy job of flying the ship, even while in the process of crashing."

"John and his guys took a spaceship and gave it personality!" Petrie declared. "It was never conceived that way- originally the ship was just going to crash-land. But they practically made this thing into a character."

Choreographed first in a rough animatic, the scene has the spaceship landing at night, skipping along a highway, flipping into the air to wipe out a streetlight, then winding up on a beach below the road- all of which is witnessed by TV producer Tim O'Hara (Jeff Daniels). "Originally the crash was storyboarded to include a hit on the cliff that started a rockslide," Van Vliet recalled, "but that wasn't worth another couple hundred grand. Donald agreed to give up the rockslide in exchange for the lamppost impact, which could be achieved with greater economy." Van Vliet coordinated with physical effects supervisor Rich Ratliff and his unit to achieve the proper interactive timings for pyro impacts, simulating the ship's bumpy touchdown. Later, at Available Light, Scott Coulter spent a full month match-moving a digital spaceship to conform with these practical effects. A final element was the ship's exhaust- a kind of glowing fairy dust. "The fantasy Tinkerbell-style glowing parti- cle look that they wanted differed from the kind of flame effect I had envisioned, but it did help set the proper mood right away." LightWave was used to produce the basic particle effect, although considerable massaging was required to impart the necessary luminosity.

Before taking on a human countenance, the Martian is seen briefly in his natural state- courtesy of a life-sized puppet built by Alec Gillis and Tom Woodruff and their Amalgamated Dynamics crew. "A lot of our work has appeared in very dark films," Gillis observed, "and some of those, like the Alien pictures, featured previously-established characters. This picture gave us the chance to do something whimsical and fresh- two aspects that were highly appealing to both Tom and me." Gillis, Woodruff, key designer Jordu Schell and shop coordinator Yuri Everson devised the fantastic creature while keeping an eye on reality. "All of us are of a similar mindset in terms of what looks real, and what looks funny. Even with all these weird elements, the puppet still had to look like Christopher Lloyd in some way. From a comedy performance standpoint, Chris practically is an alien, so we just had to create a Martian animatronic equivalent of him." To create a subconscious connection for audiences that linked actor and puppet, the lines of Lloyd's mouth were incorporated into the puppet's face.



For scenes of the ship enlarging in Tim's living room, Available Light timed its animation of the craft to coincide with interactive stage effects.

The specifics of a Martian's makeup were also quickly determined. "Donald was aware of how extraterrestrial beings are perceived in pop culture," Gillis noted, "so he wanted to tap those landmark elements while also going off in new directions. He could look at a maquette and tell you exactly what he liked and didn't like about it. His decisiveness, coupled with the innate ability to know whether something will be funny up on the screen, let us cut through a lot of the guesswork that usually goes on during the design process."

The puppet's head featured moving ears and a fully-articulated mouth capable of lip sync. "It was probably the most complex head we've ever done,"

Woodruff remarked. "There were forty-seven servos just to control the facial functions. The three eyes could be operated independently or together to extrude and retract; and instead of an eyelid mechanism, we made a membrane that stretched open to reveal the eye beneath. Dave Penikas designed the mechanics on a computer in order to take advantage of every bit of space in that slightly-larger-than-human-size head. If you took the skin off and looked through the shell, you'd see that the head was completely filled with receivers, motors and cable linkages." To enhance expressiveness, a pair of tentacle-like structures on the forehead served as the Martian equivalent of eyebrows.

The Martian's limbs were configured in a striking fashion, with two arms each splitting off at the elbow to end with four hands. "We decided against tentacles," Gillis commented, "and instead went with jointed fingers. It didn't make sense to us for jointed skeletal creatures to have tentacled appendages- you don't see that in nature. Even though this was a fanciful design, we still wanted to hold onto some rules of nature. Effects in comedy films are sometimes less than credible because someone decides that comedies don't need realistic effects. We thought that kind of attitude might compromise the creature's credibility, and maybe even the picture; so we gave it the full treatment, using silicone skins to create a natural-looking translucency."

While the cable-actuated arms were engineered by John Lundberg, the body required a group effort. "Sculptors Steve Koch and Jeff Buccacio worked out the specific contours of the puppet's body," said Woodruff, "then mechanical designer Hiroshi Ikeuchi built a big hydraulic mechanism into the body that utilized a stretch-and-squash principle to animate the character. This approach gave the Martian a lot in the way of life and expression. Between that and the ability to make him seem to rise up on his puppet legs- via rod-puppeteering or by mounting the puppet on a boom arm- there was quite a variety of heights he could work at, affording Donald more options during shooting." Much of the sense of character derived from time spent rehearsing the puppeteers before shooting. "We'd see unexpected movement combinations that were very successful in creating a sense of life and purpose- those would then be incorporated into the performance. Our hats are off to executive producer Barry Bernardi, who understood



For scenes of the ship enlarging in Tim's living room, Available Light timed its animation of the craft to coincide with interactive stage effects.

what we needed and was instrumental in getting us that rehearsal time up front.” With the multitude of moving parts involved, a dozen puppeteers were required to animate the Martian puppet.

The Martian exits from his beached spacecraft, a full-size mockup measuring seventeen feet across and featuring a fiberglass and foam hull fashioned around a steel frame armature. Originally conceived as a project to be tackled by outside vendors, the ship instead fell to Rich Ratliff. “The landing legs were articulate,” Ratliff remarked, “while both the canopy and the engine compartment opened up. The engine featured practical multicolored lights for the intakes, and those were computer-controlled so the lighting effect could be sequenced in a variety of different patterns.” The ship mockup was hauled to various locations throughout the shoot, including the beach, where it was kept under close scrutiny to insure against the possibility of tides carrying the craft out to sea. “We had to partly bury the ship, then add smoke and steam effects to simulate the crash’s aftermath.”

The mockup featured a full interior as well, with dashboard illumination and various other practical gags installed by Ratliff’s crew and controlled during shooting by his on-set supervisor, Greg Jensen. “The instrumentation was a total departure from the high-tech look seen in most science fiction films,” commented Sandy Veneziano, who was well acquainted with that established approach from her tenure as art director for *Star Trek: The Next Generation*. “The most important aspect of the ship design was that it fit with the character and nature of the Martian. So we chose control surface shapes that corresponded to the shape of these alien hand appendages, designing a series of spheres set into the consoles. He could manipulate the controls by sliding his rounded ‘fingers’ over the spheres.”

The Martian, using a handheld ‘molecular compressor,’ miniaturizes his vessel in an attempt to hide it; but while investigating the crash, Tim finds the now-tiny spaceship and takes it home with him. Veneziano’s art department designed the practical spaceship miniature, which was built by outside modelmakers and saw use on a variety of sets during production. To suggest the forces at work that reduce the spaceship to the size of a toy, Available Light executed a 3-D



To conceal his identity, the Martian assumes a human form and a human name- Uncle Martin- and doffs his spacesuit, which has a life and a personality all its own. Tippet Studio animated the computer generated apparel.



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ripple that spread across the body of the craft, along with the 'fraz' – an electrical animation element. "Whenever the spaceship expanded or shrunk," commented Van Vliet, "we removed the full-sized ship or miniature ship and substituted our digital model, over which the ripple effect was added."

Van Vliet used hand-drawn animation for the electrical ‘fraz’ effects accompanying the ship’s de-miniaturization. “Each shot was rotoscoped in order to add traditional hand-drawn electricity animation,” stated Van Vliet. “We’ve never found any computer generated electricity that performs as well. Then we scanned that art and comped it over the ship. We wrapped the electrical animation around the body of the ship, which is an old trick– but by combining this approach with the precision possible when utilizing computers, the effect was plussed up enormously. The electricity arced across the ship’s glass canopy, so we figured out how deep the canopy glass was, then gave it a back reflection from the interior edge of the glass. That’s a genuine characteristic of glass; so it became a matter of supplying the kind of secondary image that would be present in nature, then combining it with the principal one.”

Subsequent de-miniaturizations of Martin’s ship– first in Tim’s home, and later at a government lab– required on-stage rigging to create an interactive presence to which Van Vliet’s team could match its work. For the sequence in which the ship expands on Tim’s coffee table, the small craft was filmed sitting atop the table, while the full-size vessel was shot on the living room floor. To sell the weight and mass of the ship’s expanding bulk, the floor effects crew made the coffee table collapsible by running cables through its steel legs. “We expected the legs to just buckle,” Van Vliet recalled, “but they ended up crushing rather nicely.” In the lab sequence, the scale ship model was on a pedestal, with a hydraulic cabling system rigged to pull the unit down as squibs detonated. “We added camera shake, while 3-D designer and animator Ajoy Mani executed animation that really showcased the ship’s duck-legged landing gear.”

The lab and all other sets were constructed not on a studio soundstage, but within a warehouse leased by the production. “Working without traditional stages had its drawbacks,” said Veneziano. “Getting the full-size spaceship inside was difficult. Also, instead of starting with an empty space and filling it with whatever was needed, I had to work around what was already there. This included having to incorporate structural support elements of the warehouse into the actual lab set, dressing them to seem a part of that environment.”

After rendering himself invisible, the Martian follows Tim home in the hope of recovering his spaceship. Inside Tim’s living room, the invisible alien picks up his ship and attempts to steal away with the still-miniaturized craft, but Tim– seeing the little spaceship moving around in the air with no apparent means of support– tries to knock it down with a golf club. Instead he inadvertently clobbers the Martian, bending one of his antennae and causing his invisibility field to fail. The creature’s invisibility cloak was a deliberate homage to Predator. “I’ve always thought that the Predator effect was years ahead of its time,” remarked Van Vliet. “We kept that viscous-looking presence– I like how it displaces the background– but did the effect digitally instead of optically.”

Throughout the film, Martin's antennae- which echo the look established on the TV series, with a strong resemblance to the 'rabbit ears' on an old TV set- extend from and retract back inside his head. The practical antennae used on set were static creations built and applied by makeup department head Kenny Myers. "On the old TV show's antennae shots," Donald Petrie remarked, "Ray Walston had to stand very still and face exactly forward to keep those little tubes and guides behind him from being revealed. On this movie I was always looking for 'prove it' shots- the 'how did they do that?' kind of thing. I wanted to be able to see these antennae actually emerging from his head. The antenna that gets bent never goes back into his head smoothly after that, so he has to put his hand up and shove it back in. These kinds of interactions went well beyond anything dreamt of on the series, while creating a whole extra level of credibility for the film." Antennae articulations were digitally wrangled by various houses, with different methods being employed depending upon the needs of specific shots. These ranged from straightforward 2-D paint-outs by Available Light to complex tracking situations requiring 3-D animation by Hammerhead, with a variety of animated glints to further ground the antennae in reality.

To capture Tim teeing off on the invisible Martin, separate plates of each actor were filmed on set, with Christopher Lloyd's reaction cued from a video playback of Jeff Daniels' swing. One problem with the shot was its choreography. For the background plate, Jeff Daniels was required to cross through the frame, then strike at a C-stand representing the Martian in the foreground. Because Daniels passed behind the stand, it seemed for a time that some form of unbudgeted digital extraction would be necessary. "But this crew was really good," said Van Vliet. "One of the grips set the C-stand on a hinge, then waited until after Jeff had crossed behind it to swivel it up into view." The shot was also plagued by a flawed approach to the live-action. "The first time out, they shot it as a lock-off, without motion control. This should have simplified matters, but they used a rack-focus move that proved to be the undoing for the approach. The next day we set up for motion control and redid the shot."

The Martian points a finger at Tim, causing the human to levitate off the floor and sail through the room. Jeff Daniels was flown about the set through extensive wire work and the use of a parallelogram rig. After Tim is rendered unconscious during this encounter, the Martian must



Available Light created a fully digital sequence in which Tim and Martin, in a miniaturized car, are chased through a sewer by a rotor-roter.



A camerawoman, transformed into a hideous alien by Martian chewing gum, grabs a guard in a sequence created digitally by Tippet Studio.

take on his form to answer the door. A production storyboard suggested that the camera start on the Martian's face, then tilt down to focus on the alien's arm as his hand makes contact with Tim, at which point the morph begins. The transformation would be complete by the time the camera tilted back up to the Martian's face- which now has taken on Tim's visage. The altered Martin then leans down to scrutinize Tim's features. "This looked really simple on screen," Van Vliet stated, "but the execution was very difficult. It was an incredibly tricky split, because you never see the hand and arm go off camera- in fact, if you look carefully, the muscles of the arm change during the shot as we transition from one actor to the other. Jeff claimed he'd never done this kind of work before, but he was phenomenal. After watching the video of Chris in action, he was able to duplicate the arm move exactly- he became 'Mister Motion Control.' It could have been a half-day of shooting, but he nailed it on take two."

Van Vliet created the transition as an effect that traveled up the arm, combining on-set trickery with animation. "After filming the actors, I used a physical pyro element on a mechanical articulated arm. It was just a PVC tube with a bend at the elbow that matched the angle of the actors' arms. I put hash marks on the arm, indicating inches, so the effect could be recreated in 3-D if need be- though that wound up being unnecessary. Then self-illuminating pyro- which acted as an animated wipe edge for the transformation effect- went over the fake arm." Compositor Martin Hilke finessed the various elements of the split-screen shot.

Martin takes on the form of other characters during the film, including that of TV reporter Brace Channing (Elizabeth Hurley). Rainmaker Digital Pictures executed a partial interspecies transformation, morphing the actress' arms into lobster-like Martian appendages using a combination of techniques. "Her arms start to take on the striations of Martin's natural appearance," explained effects producer Mark Franco. "Based on an ADI arm supplied to us, Ron Arredondo created a 3-D texture map for the Martian skin, then tracked that in and composited the element in 2-D. There were a lot of more traditional morphing effects as well, which Brian Battles- who did an awful lot on this show - handled using Elastic Reality." Depending on the specific demands for each shot, the morphs were composited via either Inferno or Cineon.

After Martin shucks his spacesuit- dubbed 'Zoot'- the otherworldly outerwear takes on a life of its own. Inspired in part by the nostalgic, retro-sixties sensibility that permeated the production, Zoot was hardly an off-the-rack stock character, possessing a willful and wacked-out personality. "Zoot is really the movie's third lead character," Donald Petrie related. "When I embarked on this, the studio would have been satisfied if I had just put a guy with green on his hands and head into a suit. But that would have been too much like the old Invisible Man pictures."

A practical Zoot was designed at Disney by costume designer Hope Hanafin, in conjunction with Bob Ringwood. While this suit saw only limited use as Christopher Lloyd's costume, it was employed extensively- with mime Jean-Luc Martin inside- for reference plate photography that later went to Tippett Studio for CG character replacement animation, accomplished via a combination of key-framing and motion data from a man-sized input device worn by Tippett team member Thomas Schelesny. "We consulted with Tippett about the fabric and the

construction,” said Susan MacLeod, “and there were several full-size prototypes made before everyone agreed on a style that worked as both a costume and a character.”

One of the principal problems with Zoot was his physique, which, while roughly anthropomorphic, was not supposed to look human. “I wanted Zoot to be unrestrained by the bounds of human physicality,” explained Petrie. “He had to be able to deflate completely, and even shape-shift into other forms. I wanted the suit to be really otherworldly in that way. The next really challenging task was to give a character with no hands, no feet and no head some personality.”

Inspired by Petrie’s concepts and by old black-and-white cartoons, Len Morganti supplied Tippett with animation sheets that suggested how Zoot might manipulate his collar and cuffs in the way a human works his mouth and hands. Later, Petrie worked with Tippett animation supervisor Trey Stokes to develop the character further. “We spent a lot of time trying to find how Zoot would express himself. What would he look like when he’s angry or hurt?” Embellishing these emotions was a yammering Martian speech emanating from Zoot– a prerecorded track voiced by vocal effects specialist Frank Welker and synchronized for play- back on set.

“Zoot was a disembodied pair of coveralls– a jumpsuit, if you will,” related Trey Stokes. “He was fabric, a cloth character. There were no bones or structure within, but he did have a general human shape, so we had to find a middle ground between human and flexible figure. We decided that he’d generally conform to the humanoid shape, because Martin wears him in that physical configuration; but he couldn’t look like we’d shot a guy in a suit and then digitally removed the person. The basic technique started with human gestures and movements, but included unexpected, strange bends. For example, since he doesn’t have an elbow, Zoot could bend his arm in ten different places at once, then fold the whole thing up and twist it.”

As fantastic as the concept for Zoot was, Tippett and his animators strove to establish a semblance of logic to govern his behavior. “It’s a pet peeve of mine when people mess with gravity just because it is a science fiction movie,” Stokes remarked. “We decided this animated eight-pound spacesuit is as strong as the average human– if the average human happened to weigh eight pounds, that is. A person that light could jump very high and move quickly, shifting weight fast because there wouldn’t be much to shift. On the other hand, he wouldn’t be able to stand up to much– at one point in the film something gets thrown to him and the impact just flattens him. This physics-based starting point enabled us to give him a cartoon-like sensibility while maintaining the feel of a real mass occupying space in our world.”

Stokes’ fellow animation supervisor, Jeremy Cantor, adapted the motion data from the Schelesny sessions to deemphasize the human element. “While Trey was working principally on the performance end,” Cantor related, “I was concentrating on the technical aspects, like



An overzealous SETI scientist (Wallace Shawn) is tormented by Martians in an Available Light shot employing undercranked plate photography, phase-printing and 2-D image warping.

creating a workable skeleton for Zoot. That gave us a kind of global posing that allowed us to get a general performance. But there was a second layer to the skeleton that involved numerous controls- fabric motion and fluffiness, waviness to the arms, and such. There were two steps to an approval- one performance-based and the other dependent on this dynamics layer, which was largely done by hand, though Dynamation was sometimes involved as well." Since Zoot had such a wide range of motion, there were many situations in which the digital model broke apart. "All sorts of rips and tears turned up, and we found ourselves doing nips and tucks to keep the model intact for each individual shot. This meant creating additional patches and readdressing how specific seams behaved based on the motion involved."

A proprietary motion capture system was utilized to establish basic blocking for Zoot shots that would subsequently be tweaked and fleshed out by animators. Shots deemed too complex for motion capture went directly to lead animators Blair Clark and Pete Konig, who had transitioned over from modelmaking and practical creature effects. "They got our nastiest, most complicated and extreme Zoot shots," said Stokes. "Pete performed a tour-de-force of animation for a twelve-second cut of Zoot dancing, while Blair got the stunt shots, such as when Zoot twists into a ball, folds himself in half, then breaks open. Another Blair shot had Zoot getting himself wet and having to wring himself out like a sponge. There was plenty of bizarre custom animation, but the animators had to keep one foot in the real world throughout." Although the mime wearing Zoot on set had provided a performance, the animators chose to work from empty plates. "Jean-Luc was just a little too big- and much too humanoid. So, instead of tracking him, we wound up creating a whole different performance. Even so, his work was definitely important on set to show everyone what our CG Zoot was going to do." The animators did have to match some specific actions and timings from the plate elements, since various set pieces and props had been rigged on set- usually through the employment of wire work and air movers- to reflect Zoot's interaction with them.



Martin heads for home- in the Available Light ship- but turns back with the realization that he much prefers life on earth with his new friends.

During postproduction- a period that was extended as the studio jockeyed for a suitable release date for the film- a new approach was taken with the Zoot character, one that altered the relationship between a Martian and his spacesuit. "When we first did that character," recalled Stokes, "Zoot was like Chaplin- he didn't speak English. We were telling the story through his actions, narrating visually rather than through dialogue. But after we finished, the studio decided Zoot should speak and make wisecracks." When the new Zoot was test-screened, the audience response was sufficiently strong to merit even more new dialogue. With Tippett Studio now unavailable, Available Light was called upon to animate Zoot's mouth-like collar for the additional cuts.



Martin heads for home- in the Available Light ship- but turns back with the realization that he much prefers life on earth with his new friends.

While Zoot demonstrates various abilities as the picture progresses, the Martian proves himself to be no slouch in the fancy tricks department, at two points revealing magical healing powers- animated effects created by Hammerhead. Animators Sean Dever and Constance Bracewell supplied sparkle elements for a glow that emanated from Martin's body. The effect required extensive hand-rotoscoping and animated distortion maps as the glow spread from the Martian to encompass the wounds being sealed. The Hammerhead elements were printed at Pacific Title Digital.

Martians, it turns out, physically manifest signs of depression by literally falling to pieces. Martin's ability to dissociate various body parts, including his head, was suggested with prosthetic and engineering effects by ADI. "We created a number of Martin limbs, plus a static head and a neck stump makeup appliance," Alec Gillis said. "The face on the head was fixed in a sourpuss expression due to Martin's depression. Most of the body parts were just floppies, though there was a motorized foot that wiggled and a hand that closed up." ADI also provided tentacles for Jeff Daniels for a scene in which Tim is transformed into an alien.

To prevent others from discovering Martin's nature, Tim must hide various pieces of the disembodied Martian around his apartment. "I wanted to do a moving camera shot with Tim walking into the bathroom and setting Martin's arm down on the sink," Donald Petrie explained. "While the fingers of that hand drum impatiently, the camera follows Tim to a hamper containing Martin's head. Then they have a conversation that continues after Tim picks up the head and sets it down in the sink." Like the earlier scene with the golf club attack, the two actors were shot in separate motion control passes, first with Jeff Daniels playing to and handling the static ADI head, and then with Christopher Lloyd in a green suit. "We had to do it this way because when the head was in the sink, Jeff would have had to be standing on Chris' torso to play the scene. The tricky part was earlier, when Tim picks up the head out of the hamper and we transition from Chris to the ADI head. A digital eye-blink and facial movement kept the head looking alive while it was being carried to the sink." Available Light used the

movement of Jeff Daniels crossing in front of the sink to mask the transition from the dummy head to the real Christopher Lloyd, with the various passes and elements later shipped to Buena Vista Imaging for final compositing.

While earth and earthlings remain a puzzling mystery to the visiting Martian, Martin finds some consolation in ice cream, the coldness of which reminds him of his home planet. At one point in the film, Tim enters an ice cream parlor to find scoops, cones and buckets of ice cream being levitated courtesy of Uncle Martin. To put ice cream in flight on the set, Rich Ratliff's shop foreman, Peter Albiez, rigged a bicycle-spoke-style mobile mechanism that permitted both real and prop cones hung from strings to revolve. While these practicals provided some good basic reference, it was clear that considerable digital enhancement would be required to create the necessary magic.

Station X Studios completed the scene, which featured flying CG ice cream and a series of sky replacements. "In addition to losing the rig and the strings," noted Station X visual effects supervisor AristoMenis Tsirbas, "we added about five times more flying ice cream. Since Donald Petrie wanted exaggerated motions for the orbiting ice cream, we accommodated him, letting him direct the ice cream for a couple of sessions. In addition to providing timing cues, Donald thought everything was going too slow and wanted more random motion. He wanted the ice cream to orbit like atoms whipping around a nucleus in erratic orbits."

Like Available Light, the Station X crew availed itself of LightWave, though in-house tools also were employed to give the various surfaces a photorealistic sheen in the mixed-light environment. "An intense spill of daylight coming from behind the characters blended with cool interior fluorescents that we had to match to for the whole fourteen-shot sequence," Tsirbas explained. "I'd put in a shadow whenever a large bucket would orbit past Martin, but could only darken him slightly, since there's less light dispersal in this situation and the main effect of the shadow would be to knock down the color of a person's clothing. We had to render these shadows at extremely high resolution to avoid any stepping, which would give away a soft effect like this very quickly."

Tsirbas was able to utilize a practical ice cream stain on the wall near Tim, replacing it with a clean section of the plate to create a smooth, unstained area, then adding a 3-D ice cream cone and flying it towards the spot, after which he revealed the real stain. Another ice cream splat—this time on the counter—was fully CG. "I had a painting of an ice cream streak going down a 3-D card," Tsirbas said, "then animated a wipe to reveal it as the 3-D cone hit and slid down." The counter itself also required digital modeling. "Digital modeling enabled me to pull accurate reflections from the CG elements. We could then comp in reflections of the CG elements onto the real glass." In two shots, Martin uses his



Visual effects supervisor John Van Vliet and animator Bill Arance at Available Light.

strange, three-pronged alien tongue to sample from the various flavors orbiting around him, requiring a CG tongue that was rotoscoped and tracked into the scene.

When Tim orders Martin to stop, all of the objects floating around the parlor abruptly drop to the floor. "When the ice cream falls," Tsirbas said, "compositing supervisor Danny Braet worked on a bouncing ice cream bucket that hits the counter. He did it initially using a collision detection system to simulate a real gravity effect; but while that approach was a realistic one, it just didn't give us the comedic timing needed, so he went in and hand-animated over it to get the proper exaggerated timing for the bucket bounce."

The sunny blue-sky exteriors that preceded and followed the ice cream parlor sequence contrasted severely with the blown-out, white, overexposed skies originally recorded by the first unit through the parlor windows. As a result, a number of these shots required sky replacements and color correction. Additionally, shots featuring Jeff Daniels were complicated by wind blowing his backlit blond hair. "Fortunately we had the files in Cineon," said Danny Braet, "and that format supports a pretty big color range, so I could hunt for the right shade—the channel that gave me the most information so I could take a key from it. But you cannot get everything from the key, so I went in and painted additional detail in the fringes of the blowing hair. That was necessary because the image was overexposed and a lot of the hair had been lost; so the image needed restoration anyway. For background sky replacement, most shots weren't lock-offs, so 2-D and 3-D tracking was needed. Also, because the glass and doors reflected the sky, these surfaces were still reflecting the white overexposed background. We had to add 3-D elements that reflected the new sky background on these surfaces." Rendered files were given over to digital artist Andy Lesniak, who graded and timed the elements while coordinating with the lab.

The sequence ends as Martin and Tim exit the ice cream shop, with the Martian now enormously bloated after consuming mass quantities of ice cream— an effect imparted through ADI's reuse of a prosthetic belly built for Tim Allen in *The Santa Clause*. The pair are unaware that mysterious government agent Armitan (Ray Walston) is watching them. A camera pan on the duo was followed by a rack focus to Armitan, mandating a meticulous tracking job to introduce the needed sky replacement and color correction. Braet used LightWave for the track, which also involved reconstructing scenic elements. "A lot of detail was lost during the rack-focus," said Braet. "Ray Walston's white hair disappeared, so we had to paint it back in, then introduce blur so it matched all the way through the rack-focus move. I wound up softening the edges some more, doing the final touchups in Digital Fusion, then putting some birds into the background to spice it up."

Tim, his pal Lizzie (Daryl Hannah) and Zoot are captured by government forces, and a one-sided fistfight ensues. Fortunately, special gumballs— each of which allow Martin to take on the appearance of an inhabitant from a specific world— are contained within Zoot's utility belt. "The gumballs help Martin in his anthropological studies," Trey Stokes explained. "He has to chew 'human' gum the whole time he's down on earth; because if he stops, he returns to his natural state. Zoot manages to give Lizzie a special gumball from his belt— one that changes her, off-camera, into a ten-foot-tall monster. Just as the big bad guy is about to knock Tim's lights out, a tentacle lashes out and blocks the punch. Then it hauls him up in the air and flings the guy

aside, at which point we reveal the monster- a nice 'oh wow' moment- which is still wearing Lizzie's dress and shoes."

The monster, created by Tippett Studio, came into the picture late. In fact, there was no approved design even while the fight was being shot. But an inspiration borne out of an earlier scene in the film lent itself to the creature's final concept. "These scientists come up with a computer representation of what they think is a Martian's true appearance," Stokes explained, "but it's a hideous green monster that doesn't look the slightest bit like Martin. ADI had created concept art of this creature; and for the sake of irony, production suggested our monster- which was supposed to be from a planet called Veenok 7- resemble this tentacled monstrosity. So designer Craig Hayes created a CG model that was mostly teeth, jaws, tentacles- and a purple sundress, the latter being Lizzie's outfit."

While the Veenok 7 creature was animated in Softimage, with Randall Link and Tom Gibbons entering move data via a custom input device, the sundress was handled separately, using rules-based Dynamation software to supplement the key-frame animation. Software engineer Al Arthur labored to develop procedurals to define the dress movement without allowing it to intersect the beast's geometry. Testing revealed that such a pitfall could be avoided by employing a high-rez dress model; and so the dress assembly soon commenced. "Since all parts of the dress model functioned together as a single entity," Arthur said, "the pieces comprising the dress had to be combined into one geometric Dynamation object. But when dynamics are applied to a Dynamation object, the pieces separate. So they all had to be stitched together, which was done by creating additional polygons where the pieces meet." Influence maps- grids consisting of dots, with each of these points corresponding to a single vertex on the dress model- were used to establish key points on the dress, such as the shoulders.

Arthur's stitching approach also allowed vertices from different pieces to be connected. These vertices contained springs that constrained individual actions, with each spring possessing unique values for both tensile strength and inertia. "Without the springs, the vertices would have remained connected," said Arthur, "but they'd all have either flown apart due to applied dynamics or remained static without the influence of other vertices pulling on them." Creating custom springs required routines to be written that calculated variables for a number of different factors. "I set up the model's vertical connections- the columns- for greater rigidity than the horizontal connections. This was necessary in order to produce a geometry that allowed for folds in the material." There was also a draping effect, which Arthur created by varying the degree of stiffness for each column. To establish that the motion of the dress would be in keeping with a real-world environment, fields that created the effects of gravity and air were applied, with an additional touch- a shell field- used to deflect the dress away from the Lizzie-monster's legs. The finished Dynamation dress was separated into its components and ported to Softimage for combination with the creature. The dress and creature elements were then rendered using RenderMan.

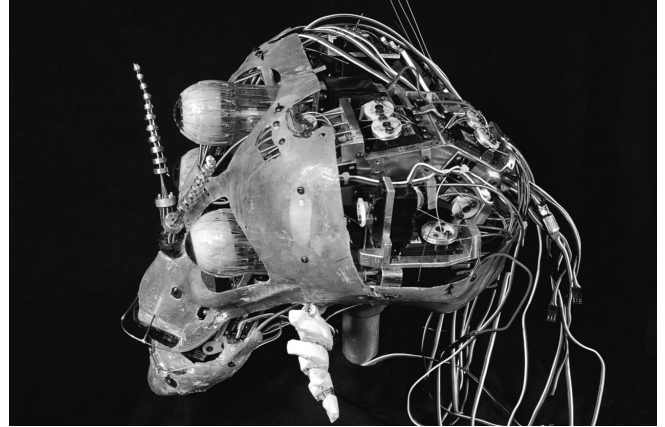
Since there were no practical creature pieces at all on set, every bit of interactivity, from shadows to lighting, had to be created in post along with the creature itself. However, the action of the stuntman playing the government goon hurling across the room had to be orchestrated by physical effects. "The guy weighed about 325 pounds," noted Rich Ratliff. "We

put him on one end of a mechanical arm and threw him first one way and then another, while twisting him. It took three of us to wrestle him around, and we spent the better part of an afternoon on that shot.” One axis of movement was provided by the arm, which swung back and forth like a crane, while additional mobility was afforded by the flying rig itself, which allowed the crew to rotate the performer at the waist through nearly 360 degrees. Finally, the stuntman added yet another axis of movement by turning himself within the yoke-like apparatus.

In addition to the greenscreen element of the flying stuntman, a background plate of the set was required. “That proved complicated,” said Stokes. “We had to track both the stuntman and the background element to get a good tie-in with our CG monster when it hauls him up into the air. The final result was pretty impressive, considering the improvisational nature of the scene.”

Inevitably, a car chase ensues, with Tim and Martin in a Valiant being pursued by government agents. To avoid a roadblock, Martin miniaturizes the car, allowing it to pass through the automobile armada and escape into a sewer. John Van Vliet developed the chase choreography using toy cars and Jawa dolls, which allowed him to work out the miniaturizing effect through a form of poor-man’s motion control that employed a tripod-mounted camera and two C-stands. “The stands were set up at the two points where the camera pan began and ended,” Van Vliet explained. “For the first take, I cued the real Valiant and the chase vehicles. Then, at the appropriate time, I whip-panned the camera around to the second C-stand- the stop-point. I repeated this whip-pan without the Valiant on take two, then substituted a digital LightWave Valiant at a point in the move when the real car swerved toward camera before straightening and continuing through frame.” The next shot featured the now-tiny CG car spinning donuts beneath the fenders of blockade autos and leaving tiny tire marks before speeding away out of frame.

A small-scale remote-controlled car was used for one shot of the miniaturized vehicle plowing through a dog dropping. “Coming up with stuff that looked right and was still soft enough for the car to drive through was tough,” remarked Ratliff. “Color was also a factor, since it had to match the material used on the full-size car. The concoction turned out to be so temperamental that its shelf life was only about a half-hour or forty-five minutes. After that it would start getting really goopy. The drive-through was shot as an insert in a parking lot behind the stage,



Uncle Martin in his Martian form was a puppet, created by Amalgamated Dynamics, that featured an expressive and highly complex animatronic head.



Sculptor Steve Koch at work on the feet.

so we'd whip up a batch, then run it outside to the setup. It's always the little stuff that turns out to be the most trouble."

Available Light's CG Valiant was originally to be featured in just the two earlier government pursuit cuts, with miniature photography being utilized for the next sequence in which the car is pursued through a sewer by a menacing rotor-roter pipe-cleaning device, only to escape by emerging in a toilet. Peter Montgomery, whose history with Disney predated even that studio's now-defunct Buena Vista Visual Effects organization, supervised the live-action work on set, much of which consisted of greenscreen photography, for shots inside the car looking ahead and behind. For lateral views of the actors, 'poor-man's process' was used, by which moving light effects, combined with a modest tunnel wall set piece, created a suitable approximation of the subterranean environment blurring past behind them. 4-Ward Productions was contracted to provide a miniature car and a series of sewer tunnels for it to maneuver through- not unlike their work for Batman Returns.

At 4-Ward, Robert and Dennis Skotak had the car, rotor-roter and various tunnels constructed in quarter-scale, then shot high-speed footage for the sequence. Unfortunately, the concept for the pursuit underwent a bit of a rethink at production- without anyone bothering to notify 4-Ward. As a result, the practical models could not fully achieve the sequence. "There were impossible limitations to the miniature approach," Donald Petrie admitted. "How do you fit the camera into this pipe that the miniature is driving through? How do you light it? The dailies were less than impressive." At Available Light, Van Vliet and Bill Arance devised a test using the digital Valiant, with the idea of generating the sewer passage in LightWave. "Their test had the car whipping through the tunnel like an E-ticket ride at Disneyland. I showed the powers-that-be at Disney the digital test alongside the model shot dailies, and everyone agreed we wouldn't be shooting that sequence using miniatures anymore. We would have figured it out for ourselves eventually, but John went out on his own and provided us with a timely solution."

With the film still scheduled for a July 1998 opening, the twenty-odd sewer shots had to be completed in a mere twelve weeks. Taking a best-of-both-worlds approach, Van Vliet utilized 4-Ward to provide the practical miniature lead-in and exit from the sewer. Additionally, 4-Ward shot a variety of practical trash elements that were composited with the LightWave elements. "They also built flats, based on their original tunnel miniatures," stated Van Vliet, "and we scanned photos of those to use as texture maps for our CG tunnel. Then we added some staining to the pipes, and plugged in specular maps to give the tunnels a nice sheen."

Van Vliet had shot photos of nearly every open sewer in Los Angeles to build up a reference library of silt, rusty pipes and gravel for texture maps in a sequence that would push the limits of LightWave's abilities. "Since this was a self-contained sequence in a truly different environment," said Bill Arance, "using LightWave worked as an artistic choice. It's a dark and scary place, which allowed us to establish our own level of reality for the duration."

Determinations about reality levels for the sewer were an ongoing ordeal for all concerned. "Conversations went places you wouldn't want to go. There was a committee deciding whether the toilet paper was too yellow. Then we had to match to the main unit poor-man's process for the side view shots, and that was more than just getting the color correct- we needed to figure out whether our blur would match their blur. Fortunately there are old ratios and relationships

for high-speed shooting of miniatures that we were able to apply here as well, and those helped us work this out satisfactorily.”

The digital sewer sequence proved to be an epic undertaking, with six of Van Vliet’s staffers working to accomplish the sequence within the minimal time frame. “First we built a section of digital tunnel, then ran the car at different speeds through it,” Arance explained. “Basically we were doing speed trials in a virtual world. Putting a digital car into a digital background gives you all kinds of control, but it also lets you step all over yourself with the multitude of options. Ultimately, what governed the car’s actions was the thought of how Donald would direct it to behave if it were a live-action character.” In the final sequence, the virtual camera would get to within a mere five feet of the digital car. “With that kind of closeup, we needed to see bug hits on the windshield, the registration sticker on the license plate– everything. Even after adding all that detail, we still had to go darker and moodier, then play with the specularity to give it a spooky, menacing look.”

Available Light also fashioned a CG version of the rotor-roter, basing it on the 4-Ward miniature. “Sparks fly off the unit to simulate the friction as it passes through the tunnel,” Van Vliet observed, “but the real reason that the sparks are visible is for this really cool staccato lighting they provide with-in this dark tunnel. Just a couple of bright frames flashing on, with lens flare and monster shadows coming off the unit, created a great spooky mood.” Stylistically, Van Vliet hoped to engage the audience in the chase through the exaggerated use of color. “We were going to have ‘hope’ colors up front– blue and white– with red for ‘evil’ in the rear. Every time Tim and Martin look behind, they see the red of the taillights, with this awful rotor-roter right behind. After color-timing each scene, we used this color scheme to trigger the desired response, though a few little fill lights were added to make the car’s exterior read better.”

Available Light built a series of sub-chambers for later shots in the sequence, though these were also augmented with practical 4-Ward elements. “Bob and Denny Skotak provided a foreground cigarette pack that got blown out of the way with air rams during the car’s passage through the sewer,” Van Vliet recalled. “The foreground bars at the end of the main tunnel are theirs, as well. Production shot an oversized candy bar wrapper that ends up draped over the windshield before being blown clear and falling into spinning fan blades. The resulting in-scale dicing was also accomplished by the Skotaks, who threw matzohs into a fan to create the shredding effect.”

The car veers suddenly down a side path to avoid a similar fate at a climactic moment in the sequence, and winds up in a water stream. Skotak elements of real water and goo were incorporated into digital maps painted by Ajoy Mani at Available Light, who worked from concrete textures photographed by Van Vliet as a basis for the stream bed. Van Vliet also took the 4-Ward water element and mapped it into the tunnel’s terminus– a toilet. Chad Cole and Kevin Van Hook worked on animation for the end of this scene, with Available Light motion graphics expert Tony Venezia handling digital compositing and Martin Hilke taking care of 2-D chores. Views from inside the live-action car looking out, for the toilet-breaching along with earlier tunnel POVs, were composited with the Available Light backgrounds by Rainmaker Digital.

The Valiant de-miniaturizes within the toilet, exploding a commode built from stearic acid for easy fragmentation. "There's a guy sitting on the toilet when it blows up," Rich Ratliff related. "We staged the detonation with a dummy. Then, when the guy gets swept up onto the real car- becoming a kind of human hood ornament- we used a stuntman, who is taken along for a ride as the car barrels along and crashes out through the front wall of the house."

Eventually Martin reboards his ship and, after bidding a fond farewell to Tim, lifts off. The series of shots took place in Malibu, with the main AT&T relay station for the Pacific Rim serving as a striking backdrop to the departing spacecraft. "Seeing these three big antenna dishes back there, you'd be shaking your head and thinking, 'That's got to be a matte painting,'" said Van Vliet. "Fortunately they had some searchlights going in the background, so I was able to chart the ship's path so it would pass through them, which was a nice little bit of interactivity." Additional elements tying the ship to its environment included synthetic smoke through which the ship's headlight beams passed while it lifted off.

Martin's absence is a short one, as he soon returns to Tim's apartment, electing to remain on earth, while Armitan- now revealed to be a long-stranded countryman of Martin's- takes to the controls for a homeward flight. "The scene where Martin flies up the driveway prior to landing," said Van Vliet, "is a good example of how director of photography Tom Ackerman helped us out. He ran a golf cart with a light on it up the driveway- that gave us the light spilling on the leaves, which were also being blown by wind machines. The CG ship integrates with the live-action well for two reasons: our LightWave model was a good match with the full-size mockup, allowing the two to be intercut directly, plus our successful mapping and duplication of the production lighting. All of that on-set interactive light really made it easy for us to lock the CG ship into the set plate." Later, when the ship lifts off, even more complex interactives were employed. "A couple of guys had mounted 5Ks on a tilt bar, so I gave them timings for lifting this rig- which suggested the ship was rising and pivoting round. I also shot a hot spot for the ignition point, then split in a leaf-blowing gag to cover the grips in the foreground. In post we again added a blast effect for animation on the ground- a jet-type, 3-D heat thrust ripple that involved our mapping the background over a distortion that hooked up to the spaceship and followed it around."

The night exterior was another warehouse set, which had to blend seamlessly with wider views of an actual apartment in Santa Barbara. "We really wanted to get out and away from Los Angeles," said Sandy Veneziano. "Donald Petrie wanted to shoot in the Pacific Northwest, but the budget couldn't accommodate that, so we settled on Santa Barbara." This decision allowed the production to remain close to home while still taking advantage of the town's scenic aspects, including spectacular ocean vistas and proximity to Stearns Wharf, where the ice cream parlor sequence was shot.

The film concludes with a bird's-eye view of the apartment and its environs as the ship takes off into the heavens with its trademark pixie-particle flourish. Shot from a cherry picker, the plate could have been fraught with steadiness difficulties, but good luck held sway. "In even a slight breeze," Van Vliet stated, "the camera could have been bobbing back and forth like a metronome, but fortunately we didn't encounter any winds. The shot required a quick tilt-up to

follow the departing spaceship, followed by a pan over. We animated the ship backwards from the whip move- our cue event- and then added the tracked-in starfield and Tinkerbell-style exhaust.”

By the time *My Favorite Martian* was finished, the sophistication and sheer magnitude of its visual effects helped to obliterate many similarities to its low-budget sitcom origins. Even so, the movie managed to retain the series’ sense of whimsical fun and its intimate character-based focus. “I was a big fan of the original series,” said Donald Petrie, “even though I was just a little kid at the time. So the idea of carrying on the show’s basic premise was an intriguing one. The thought of doing something with a lot of visual effects appealed to me at the time, as well. Of course, while making the film, as I watched all my shooting time go down the drain because people had to measure the set and put little orange balls all over the place, I thought to myself, ‘Never again.’ But now that it’s all done, I say, ‘Oh yeah- I’d do it again.’ I guess you tend to forget all the horrible times. When the finished product comes out, all you can think is, ‘Wow, that’s amazing.’”

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T-REX-BACK TO THE CRETACEOUS THE FIVE-TERABYTE SOLUTION

article by Joe Fordham

In 1953, Paramount Pictures introduced Vistavision, a widescreen film format that laid 35mm film on its side and ran it horizontally through the camera, producing an image area that was twice the size of the vertically-fed four-perf standard. Metro-Goldwyn-Mayer countered in 1959 with a vertically-fed 65mm five-perf format, Camera-65, for its epic Ben-Hur. Expo '70 in Japan, however, saw the launch of Imax, the largest moving picture film format yet, developed in Canada by Graeme Ferguson, Roman Kroitor and Robert Kerr. The Imax process took 65mm negative, ran it sideways like Vistavision, and blasted the resulting fifteen-perf frame up onto a screen more than six stories tall and ninety feet wide.

Transitions, unveiled at Expo '86 in Vancouver, was the first full-color 3-D film released in the Imax format. Eleven more Imax 3-D projects followed- hurling everything from buffalo to dust mites, fish and even Mark Twain into the third dimension- with offerings since 1990 utilizing the latest electronic liquid-crystal shutter glass technology. But with the late 1998 release of T-Rex: Back to the Cretaceous, Imax opened the door to even grander possibilities, trading its traditional documentary formula for a fictional time-travel story in which photoreal stereoscopic dinosaurs- created entirely in the digital realm- leap off the screen into the faces of rapt viewers.

This singular cinematic challenge was given to director Brett Leonard in February 1997 when he and partner Michael Lewis, co-founders of the Santa Monica studio L-Squared Entertainment, were approached by T-Rex executive producer Andrew Gellis with the idea for a dinosaur-themed show in which a young girl is magically transported back to the Cretaceous. Leonard, having previously directed such visually innovative films as The Lawnmower Man and Virtuosity, embraced the opportunity to work in large-format stereo. "I was a child when I saw my first Imax movie, To Fly," Leonard recalled. "I remember being captivated by the size of the screen. It was almost a mystical experience." As a filmmaker, Leonard continued to be intrigued by the creative and pioneering aspects of the Imax venue- especially in its stereoscopic mode. "Imax 3-D is much more of a mise-en-scene filmmaking medium. You create an environment, you sculpt that environment with long-take, moving masters, you focus the attention of the audience through choreography in the shot, and also volumetrically. You really have to think completely differently as a filmmaker than you do with 35mm. It's a very intimate medium, probably the most intimate there is. Whereas Imax 2-D is pure spectacle and scale, with 3-D you get inside the experience, right in there with the characters."

If Leonard welcomed the creative challenges of working in a still-developing medium, he also recognized the enormity of the project he was about to undertake. "Imax filmmaking had been documentary filmmaking up to that point," Leonard related, "very wonderful documentary filmmaking, but not designed to do a super high-tech, photorealistic dinosaur film, which was about as far as you could push it. So we really had to create and invent structures to support

what we were going to do. In addition, there were hundreds of technical challenges to overcome- things that I didn't even realize were issues in stereographic 70mm that you just take for granted in 35mm. In a way, the experience was like being back in 1915 Hollywood trying to make feature films for the first time, and there's no real infrastructure there to support you."

To determine if the film could be done for the budget Imax had in mind, L-Squared embarked on a five-month feasibility study. "We went through a whole development phase," recalled visual effects producer Jini Dayaneni. "We took the script and storyboarded it, designed the entire shoot and put together a proposal for Imax on what it would take to do the film- with a pipeline, a methodology and a postproduction schedule." Brought on board to assist Leonard and Dayaneni in developing the show was visual effects supervisor Sean Phillips, whose technical expertise in stereography and large-format films would prove invaluable to the team. "Sean really helped us put the show together and made it possible for us to get the best stereo imagery. He was excellent at pushing the art direction and figuring out what it would take to create dinosaurs that an audience could believe in." In addition to creative input at the outset, Phillips' technical contributions included getting a bluescreen system operational, testing film stocks for it, and designing and fabricating a motion control system for the Imax 3-D camera.



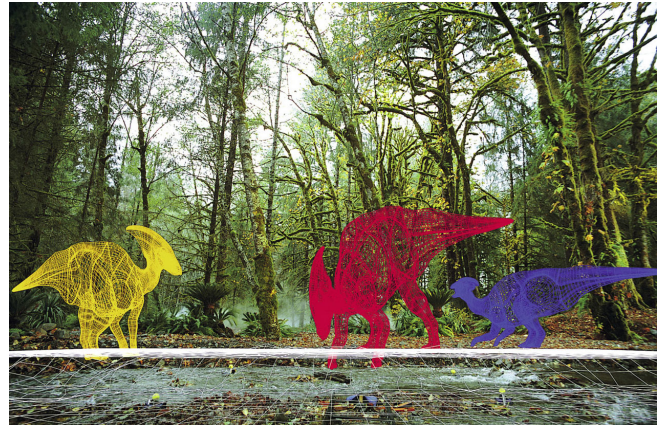
In the Imax 3-D production of T-Rex: Back to the Cretaceous- directed by Brett Leonard of L-Squared Entertainment- teenager Ally Hayden (Liz Stauber) is whisked into the prehistoric past where she finds herself in perilous proximity to a Tyrannosaurus rex defending her nest and eggs from a thieving ornithomimus.



Live-action for the Cretaceous sequences was filmed in the rainforests of Olympic National Park in Washington. Plates that would later include dinosaurs then went to Blue Sky|VIFX where the prehistoric beasts were created in the digital realm and match-moved into the live settings.

Toward the end of the development phase of the project, L-Squared ran some internal stereoscopic tests to help define the technical parameters of the anticipated CG dinosaur effects. “We had just finished the visual effects on *Pirates*, another large-format, five-perf stereoscopic film for a Busch Gardens interactive show,” recalled Dayaneni, “so we decided to take the geometry and the objects from that- a bunch of CG bats flying around- and rerender them onto the larger Imax frame.” Concurrent with its in-house testing, L-Squared also began scouting for an outside company to handle the T-Rex digital effects. “We knew, because of the size and scope of the project, that this wasn’t going to be something that we could do in-house. We needed to recruit a fairly large company, a place that was big enough to handle the kind of data that we knew we’d be dealing with and that had the infrastructure to support the size of the show.”

Dayaneni would find what she was looking for in Blue Sky|VFX, a company that had proven itself in photorealistic rendering and character work with such films as *The Relic*. Since BS|VFX was new to large-format stereoscopic filmmaking, however, company president Richard Hollander decided to conduct additional testing prior to bidding the project. “It’s hard enough to create a 2-D image that looks good,” Hollander observed. “But in Imax 3-D, the resolution requires more information because the frames are so much larger. Then you have twice as much information because there are two frames. Plus you have to work with objects in 3-D space. It’s not two times harder; it’s not four times harder; it’s somewhere around twenty times harder.” The test shot, conducted under the direction of visual effects supervisor Nick Ilyin, consisted of scanned-in background footage provided by L-Squared into which a CG character- the Kathoga creature previously created by VFX for *The Relic*- was inserted. “We rezzed him up, rerendered, repositioned and relit him,” recalled Ilyin, “then stuck him into the three-dimensional background consisting of some seventy-two frames of footage. From that, we got an idea of how long it was going to take to render, how long it was going to take to composite, and we used that as a basis for bidding the project. Though it taught us a lot, it was still a static shot in which we basically took a creature that was fairly small on screen and stuck him in a background that was fairly distant. So there were a lot of complicated 3-D issues that we had yet to discover.” 1



Live-action for the Cretaceous sequences was filmed in the rainforests of Olympic National Park in Washington. Plates that would later include dinosaurs then went to Blue Sky|VFX where the prehistoric beasts were created in the digital realm and match-moved into the live settings.

Such issues would soon come to the forefront, however, as both companies began to grapple with the enormous technical challenges of the show. “All 3-D, up until Imax, was convergence based,” Sean Phillips explained. “The stereographer used convergence to set a window for comfortable viewing of the scene, and some discreet objects—usually projectiles—were allowed to protrude through. With Imax 3-D, however, you have to completely change your thinking because you blow away the frame line. There’s no longer a regulation for applying convergence. You still use it occasionally as a tool, but much less often. What’s great about the format, though, is that it allows you a continuity of depth from infinity to within inches of your nose. And as long as it’s directed correctly— you don’t want to have actors walking off the sides of the frame, for example— you’re not aware of any frame line.”



A tracking shot of parasaurolophuses drinking from a stream required meticulous match-moving and replacement of the real water in the plate with computer generated water to permit appropriate interaction with the digital dinosaurs.

One of the biggest issues that BS|VIFX found itself addressing was how to deal with the sheer volume of digital information that would require storage. “Our projection was that we would be working with about three terabytes of data,” said vice president of technology Mark A. Brown, “but we actually ended up with almost five— that’s five thousand gigabytes, or five million megabytes. So expansion was part of our plan. We knew there was going to be an intense amount of rendering, and we had to project it to the end to determine if we could make a pipeline that would work.”

The feasibility study and advance testing provided L-Squared and BS|VIFX with sufficient data to recommend that the project go forward. “The Kathoga and bat tests were good representative tests,” remarked Phillips, “because we chose wide shots— the hardest thing to do in Imax since the resolution demands are so high— with a lot of intensely detailed foliage, flowers, grass and trees that were moving very slightly. We knew the dinosaurs would be easier— because you can usually get away with two-thirds or even half of your scan resolution— so they could be rendered at 3K resolution, sometimes even less. For the backgrounds, however, we were under a lot of pressure to work at 5.5K, even though we knew that we just couldn’t get the whole film done at that high a resolution.” The issue was settled by process of elimination. “We did 4K, we did 4K sharpened, we did 5.5K down-rezzed to 4K output, we did 5.5K up-rezzed to 8K output. Then we took a vote on which looked best. The consensus overwhelmingly was 4K sharpened. At that point, we knew we could do the project.”

In June 1997, T-Rex: Back to the Cretaceous was greenlit, and the production began gearing up for the start of filming in the Olympic rainforests of northern Washington— which would double for the primeval landscapes of the Cretaceous Period— and at other selected locales in Alberta, Canada. Eight dinosaurs were chosen to represent the film’s prehistoric fauna: three versions of Tyrannosaurus rex, ornithomimus, deinonychus, pteranodon and parasaurolophus— a subspecies

of hadrosaur. Sculptor Michael Trcic, a dinophile active in the paleontology community whose credits included Jurassic Park, was engaged to create scanning maquettes of each dinosaur. Working with him were scientific consultants recruited by L-Squared- among them Philip Currie of the Royal Tyrrell Museum of Paleontology in Canada, Lawrence Barnes and J.D. Stewart of the Los Angeles Natural History Museum, and paleoanatomist Cara Burres, who provided musculature and skeletal drawings and later worked with animators on dinosaur movement.

“Our paleontologists were very involved in the sculpting process,” observed Leonard, “because our dinosaurs had to be paleontologically correct. This was an Imax movie, after all, and it was going to play in some museum institutions. So the whole process of designing the dinosaurs, sculpting the dinosaurs, digitizing them and modeling them in the computer, coming up with texture maps, the muscle deformation- all of it had to be based on skeletal data and fossil records, with paleontologists consulting every step of the way.” The laborious undertaking was aided by an electronic site where film imagery of the evolving dinosaur designs could be posted and feedback gathered. “We had put together a huge reference packet,” recalled Dayaneni, “that included everything from information on what we thought the inside of a dinosaur mouth might look like to what the skin textures might be, based on our paleontologists’ input. But since it was such a huge collaborative effort with so many people involved, we created the electronic approval site so that everybody could log on and see the work-in-progress. We could get everybody’s comments firsthand, whether they were in Canada or on location shooting plates.”

Once the sculptures were digitized and databases assembled in the computer, the digital team at BS|VIFX began the task of texturing the models, animating them and putting them in stereo space, with muscle deformation and interactive effects. “We had about eight different people painting textures,” said digital animation supervisor Michael Necci. “We tried to go for more distinctive colors, patterning and so forth, because bright coloration was part of the current scientific school of thought that we were following. We took that as far as we could; but we were also battling perception issues. If you see a brightly colored T-rex, you’re just not going to buy its scale. So we had to pull a lot of that back. We had a real hard time with the orni. He was bright blue and yellow, and we eventually had to tone him down just to make him look real; otherwise he was too cartoony. There’s still some blue and some yellow, but it’s definitely muted.” Scars and aging effects were added to the skin textures so that they did not appear shiny and new.

Motion studies for the animation work were also underway. For reference, Necci and his team of animators studied ostriches, emus, rhinos and elephants. “We wanted to observe how large creatures move,” Necci said, “especially how the skin works.” The CG animation, accomplished using Maya and Alias Wavefront, would benefit additionally from the expertise of the film’s



Having discovered a nest of tyrannosaur eggs, Ally is startled by the sudden appearance of an ornithomimus intent upon stealing one.

scientific advisors- in particular Cara Burrell. "She guided us to make our dinosaurs a little more lively, a little more energetic through quicker movements, as opposed to plodding. We looked at film footage of Komodo dragons, which most of the time are very slow, plodding creatures; but when they're hunting, they have bursts of energy and move extremely fast. That's the quality we were going for."

Although the modeling and character animation work for the CG dinosaurs were no different in large-format than in 35mm, what would complicate the task immeasurably was the demand for absolute perfection of detail since the images on the screen would be so huge. "We just had to keep going back, pushing detail, detail, detail with all the artists," stated Leonard. "Detail in the muscle, detail in the muscle deformations, the way that the deformation maps were added, the skin sliding. The detail needed to be well beyond what you'd have to do in a 35mm film in order to sell these creatures as real- because they're all in daylight, they're displayed in huge scale, and they come off the screen within three feet of your face."

As BS|VIFX prepared for the onslaught of plate photography from the live-action shoot, Leonard and his crews toted the heavy Imax 3-D camera on location. "We used a 250-pound unified camera rig," stated Phillips, "which has two strips of film running within a single body and two lenses joined together, fixed at 2.85-inch interaxial- which is the distance between the lenses that creates your sense of perspective or depth. Beam-splitter rigs - where you can control the stereo 100 percent- are even bigger. They can weigh as much as five hundred pounds." The choice of cameras was crucial to Leonard, who wanted to push the envelope of how an Imax film is shot, with much more moving camera work. In order to afford him the latitude to move about freely on location, heavy-duty camera rigs were designed, along with a special motion control head constructed by Phillips for the Imax 3-D camera. "I adapted it to my Kuper system for motion control," said Phillips, "and John Higbie worked up an interface between the Kuper and the 3-D camera."

The live-action shoot would encompass some forty days of filming, with approximately 12,000 feet of 65mm film expended per day. Lending his considerable expertise to the endeavor was camera operator Noel Archambault, one of the world's top authorities on stereography. Tragically killed in an accident while filming a subsequent Imax 3-D feature, *Galapagos*, Archambault had shot a majority of the Imax 3-D movies- which by the sheer physicality of the medium are virtually impossible to see until projected in their finished form. "You can get 3-D viewfinder systems that put up a 3-D video image," commented Phillips, "but they're pretty much useless, because the effect when it's projected on the big screen is so dramatically different- it's not a true representation of what you are going to see in the full format. The only way to really see it is to print it on 70mm and project it- which, of course, is very expensive. You're better off just relying on your experience."

Back in Los Angeles, Consolidated Film Industries received dailies from the production and processed 35mm print-downs of the separate left eye, right eye 70mm images. "By the next day," noted Phillips, "they'd have a report to give us of what the dailies looked like. Then, to make sure everything was correct camera-wise, they also examined the combined images in 3-D to make sure that there were no sync problems with our system." Since the 35mm print-downs were not a true representation of how images would appear in full format, Leonard occasionally

requested that key scenes be printed in 70mm so that he could better judge the aesthetics of a shot. “We’d print certain scenes that were really pushing the edge,” said Leonard, “like when we were cutting to closeups– which is done very rarely in this medium– or if there was a camera problem and we had to make sure that we could work with it in post.”

Selected background plates were scanned at Imagica, a digital facility specializing in large format. “The challenge from the get-go, once we started receiving plates,” remarked BS|VIFX visual effects producer Nancy Rushlow, whose job it was to interface between BS|VIFX and L-Squared, “was having enough time for each department to work on the shots. Fortunately, Mark Brown was always one step ahead, making sure I had what I needed to get them out the door.” Faced with huge amounts of digital information from the high resolution, fifteen-perf 70mm frames, Brown and his crew devised ways to address the complexities of storage. “We had frames that wanted four gigabytes of memory to render,” said Brown. “We had four-gigabyte machines; but you can’t render an eight-hour frame on one machine. So we wrote utilities to split the frames up into twenty, forty, sixty pieces so we could get small bite-sized chunks that were manageable. This made our pipeline more efficient so we could see things more easily.”

Handling the huge database, however, was only one part of the challenge. With shots rolling in, the full extent of the postproduction task became evident, not just in terms of the exacting modeling and animation work involved in creating photoreal CG characters– a first for Imax– but also in terms of tracking those characters into the live-action stereo plates. “Just getting the dinosaurs’ feet on the ground was a very large problem,” explained Leonard, “because we found that the human brain can see half a pixel off in stereoscopic space. If the tracking is not done just right, it feels like objects are kind of floating. If our dinosaurs were just two inches too high or too low, or if they were too far back or too far forward in the scene, it didn’t look right. We didn’t know that when we first went in. In 2-D, you can be six feet off and it still looks perfectly fine, as long as the perspective is about right. But when you’re dealing with stereo, you have to get it dead-on.” In retrospect, it was obvious that the pixel-offset problems had arisen due to the practical limitations imposed by shooting background plates under severe conditions in a rainforest setting. “We’d been given a very short window in which to film the movie, so there wasn’t a lot of time to gather measurement data on the locales,” Ilyin related. “We would take measurements, shoot the plate, and five minutes later the crew would go on to the next setup, destroying the previous setup in the process. We did the best we could in the time we had.”

Michael Necci’s team worked long and hard to address the problem, with digital compositor Joel Merritt devising an ingenious way of tracking the ground in the background plates after the fact, since no ground data had been obtained during the shoot. “Joel’s system involved taking the left-eye and right-eye footage and doing a kind of interference pattern in order to triangulate a ground contour,” stated Necci. “Unfortunately, it was only eighty to ninety percent accurate. The last two months of postproduction were spent



doing a lot of brute force work, trying to get our dinosaur feet to connect to the ground.” In retrospect, grabbing ground data on location would have been helpful. “We could have done a lidar survey,” stated Brown. “I think now, because we were forced to develop utility code around it, we understand what we’re trying to do a lot better.”

One technique that Necci did adopt, which greatly enhanced the technical 3-D viewing process at the workstation, was a low-tech strategy designed to turn the workstation into a version of a Victorian stereoscope. “We wrote code to put 3-D glasses on, look at a monitor and see what was going on,” Brown explained, “but we found the better bet was the old mirror trick with a couple of monitors. You take a double-sided mirror and, by positioning the mirror a certain way, you get stereo off two images as opposed to having to use the spiffy LCD glasses.”

Five minutes of computer animation were ultimately incorporated into the forty-five-minute film. VIFX 3-D digital effects technical supervisor

Theodor Vandernoot worked closely with digital compositing supervisor Mary Leitz to track and combine the images. One of the toughest shots would involve the first appearance of dinosaurs in the film. As the story unfolds, teenage budding scientist Ally Hayden (Liz Stauber), accidentally knocks a rare fossilized dinosaur egg to the floor in the museum office of her paleontologist father. Cracks appear in the egg and it emits a mysterious gas– a 3-D animated effect farmed out to Tim Sassoon Film Design and generated on a Macintosh. Disoriented by the gas, Ally wanders into the museum’s exhibit halls, where she encounters a Tyrannosaurus rex display skeleton that incredibly begins transforming before her eyes into a living, breathing, flesh-and-blood dinosaur.

Vandernoot began R&D work on a T-rex model for the sequence by initially devising skin texture for the outside of the model, and a bloody red muscle texture with cartilage on the inside. “We shied away from that eventually because it was too gory,” Vandernoot admitted. “The guys in the character department developed the skeleton in Maya, doing animation deformations in Houdini and using custom code that Nick Ilyin wrote called N-Bones. Then I created four layers of flesh, cartilage and muscle, with skin on top of that. They grew in succession in 3-D. It’s not a traditional 2-D erosion-type reveal, because there is a three-dimensional geometry being created from nothing. Any stacking or layering is a dead giveaway; so you’ve got to build all the layers at the right spatial relationship at the same time.” Procedural shaders C++ and RenderMan afforded render times, at full resolution, of about ten minutes per frame for the final character.

Unafraid of the towering T-rex, Ally retrieves the pilfered egg and examines it for damage before returning it to the nest.



A pteranodon glides through the rainforest. Blue Sky|VIFX supplied five minutes of computer animation– featuring five different prehistoric creatures– for the special venue production.

As Ally flees from the T-rex, corridor walls dissolve and give way to a tumbling vortex of museum artifacts that takes her millions of years back in time to the primordial woodlands of the Cretaceous. "The time tunnel came together pretty smoothly," Ilyin recalled. "Brett had an idea of what he wanted, an artist storyboarded a dozen frames, we did wire-frames of the motion, and a little bit of fudging with the interocular to make it work in 3-D. It was actually one of the shots that we thought would be a major deal, and it ended up being fairly simple. It was easier doing CG in stereo in a CG environment than matching CG with live-action in stereo."

A case in point was a later scene in which Ally comes across a family of hadrosaurs drinking at a river. The scene- a tracking shot with the camera at ground level pushing in, with lens distortion- was particularly grueling in that it required the interaction of the CG dinosaurs with water. "Unfortunately we didn't have L-Squared's motion control on set when we were shooting the scene," stated Ilyin, "but we didn't think it was going to be all that difficult. We had done some tracking here for Titanic, so we figured it would be easy if we just had enough registration marks in the lake area- which we were going to cover over anyway."

While Jennifer Ann Howard rotoed foreground rocks to place the hadrosaurs in the environment, Vandernoot and Keith McCabe attended to the creatures' interaction with the water. "It was an amazing shot," noted Vandernoot, "because the hadrosaurs had to be walking in just the right place, we had to have the water- which is splashing and reacting to their feet- in the right place, and we had to have drips coming off the moving animals into moving water." To accomplish the effect, Vandernoot ended up completely replacing the live-action stream in the background plate with CG river stones and CG water flowing on top. "We tried a couple of different approaches, writing actual geometry code for the water and then using Areté software- but it wasn't really working. So I wound up writing procedural codes for RenderMan instead. But then I needed somebody to drive it and control it and actually animate it. Keith took the dinosaurs' feet positions and artistically animated the water, making the plug-in work." Three-dimensional tracking of the digital dinosaurs in the scene was accomplished by Joel Merritt. "We owe a lot to Joel," noted Mary Leitz. "He was the one staying late, hand-tracking a foot to a rock. We even had to cut off one of the hadrosaur's legs and render it separately, because it started to stretch. It was a stickler to the bitter end, but I think the final result really sells."

Finding herself back in the museum after her T-rex encounter, Ally wanders into another area of the exhibit hall where she comes upon a painting by Charles Knight, an early twentieth-century paleontologist renowned for his remarkably detailed dinosaur depictions. As Ally stares at the canvas, a pair of fighting deinonychuses in the scene spring to life. "In our initial discussions," said Ilyin, "the painting was going to transform from being a 2-D painting to a 3-D painting, transitioning the dinosaurs as well. Once we tried this approach and projected it in 35mm 3-D, however, we discovered that the effect was more annoying than clever. We then decided to keep the painting in 2-D as Ally walks up to it, but after the cutaway come back to a full 3-D painting with 3-D dinosaurs coming out into the theater space." Ally finds herself magically entering the painting, where she encounters Knight himself at work on one of his paintings. Taking leave of him, she stumbles across a T-rex nest and an ornithomimus trying to steal its eggs. The T-rex mother appears; and as the much-smaller ornithomimus attempts to flee with its booty, the

enraged T-rex grabs the egg-snatcher by its tail and flings it away. Animator Jeff Lin orchestrated the action. “Jeff did an exceptional job,” said Phillips. “It was one of those shots that really works emotionally- very dynamic action, very convincing animation, really nice dappled lighting that illuminates both of the dinosaurs.” Attention to detail also helped sell the scene, with BS|VIFX devising an effective particle scheme that enabled the leaves on the ground to react to the dinosaur footfalls. Other subtle tricks were devised to anchor the CG creatures’ feet to the ground. “When the dinosaurs are chasing through an open field and the T-rex stomps the grass,” said Necci, “we matted the grass down, then had it spring back up as the T-rex moves on. It was extremely subtle but really integrated him in the scene. In all the shots, we had the dinosaur feet penetrate the ground at some level, so it always looked like the feet were on solid ground.”

Having dispatched the ornithomimus, the T-rex turns her attention to Ally, who retrieves the pilfered egg and gently returns it to the nest. The T-rex leans in toward Ally, and she extends a tentative hand to stroke the looming beast on the snout. “The whole film builds to that moment,” Leonard noted. “That was sort of our E.T. shot. You really had to believe that Ally was touching that mama T-rex.” To accomplish the lengthy two-shot closeup, framing just the T-rex’s head with the girl, the actress was first filmed petting a T-rex mockup head. “It was moving and wasn’t placed exactly where our CG dinosaur was,” stated Leitz, “so I had to track her hand and track the CG dinosaur, then find a point at which to put them together. Again, it was a lot of trial and error getting the tracking right.”

The magical moment ends with a bang as a gigantic asteroid cuts across the sky and impacts off-screen, decimating the T-rex and obliterating her world in a pyroclastic shockwave. Ally is propelled forward into the present, landing unharmed back in the museum, at the foot of the T-rex skeleton. The climactic, single-shot sequence- encompassing some 300 frames from asteroid flyby to reappearance of the museum- provided BS|VIFX with one of its biggest challenges on the project. “Tomás Rosenfeldt, who did a lot of ash and cloud work on Volcano, developed the blast wave rolling out toward the audience,” noted Vandernoot. “All of the 2-D glow effects and the blast timing effects were done by Mary Leitz, while Bob Mercier worked on the rocks and volumetric stuff that envelops the audience. The disintegrating dinosaur was mine. I worked with Mark de Sousa, who hand-drew all the serrated skin pieces on its body. Then I developed a procedural graphic interface that allowed us to type in the speed, tension and force needed to rip it apart. It took about two months to figure out how to do all that.”



On location in the Olympic rainforest, chosen for its primordial look, the L-Squared Entertainment production team readies the ponderous Imax 3-D camera for a circular tracking shot.

T-Rex: Back to the Cretaceous concludes with an equally impressive, albeit smaller-scale, effect as Ally walks away from the fossil egg that launched her time-travel adventure. Behind her, the

camera zooms in for a closeup as the egg rocks, cracks and finally hatches. A slimy baby T-rex emerges, leaping directly at the audience and freeze-framing in the film's final image. Matthew Hausman supervised the egg effects, an entirely digital sequence. "The tracking was amazing," remarked Phillips. "There were stacks of papers on the table, and we scanned some of those so that as the baby T-Rex breaks out of the egg, he slips on the loose paper and it moves accordingly. That worked well because you really buy that one is tied to the other. Interaction was the key."

Nominally educational, visually stunning and wholly entertaining, T-Rex: Back to the Cretaceous proved beyond a doubt that the very visceral experience of large-screen stereo in combination with dynamic computer generated visual effects makes for a powerful result. Already in production for its next Imax 3-D show, Siegfried and Roy: The Magic Box- which features a full twenty minutes of CG- L-Squared Entertainment hopes to position itself as one of the premier companies doing large-format pictures. "Things are really changing in the large-format community," said Jini Dayaneni. "More and more theaters are being built, and with films like T-Rex there is an opportunity for commercial enterprises to make their money back. That will, in turn, allow us to have bigger budgets."

For Brett Leonard, the inevitable drive toward feature-length Imax fare- particularly in stereo- holds infinite possibilities. "We're definitely going to be pushing for more character development in the medium and in the pictures that we do at L-Squared," Leonard commented. "With Imax 3-D you get something that you can't get in any other medium- scale and intimacy. To me, it fulfills the promise of pure cinema."

T-Rex: Back to the Cretaceous photographs copyright © 1998 by Imax Corporation. All rights reserved. Photographs courtesy of L-Squared Entertainment and Blue Sky|VIFX. Special thanks to Amanda Roth, Scot Byrd and Todd Erickson.

BABE-PIG IN THE CITY MEAN STREETS

article by Joe Fordham

It was an odd, unexpected contender for best picture of 1996: a small, unpretentious film about a humble talking pig named Babe that managed to win the hearts of both critics and audiences. Babe– directed by Chris Noonan and produced by George Miller– was the dark horse nominee, and it did not win the best picture Oscar. It did, however, earn a golden statuette for best visual effects, beating out the bigger-budgeted and higher-profile Apollo 13.

The orphaned pig with the kind and steady heart had first taken hold of George Miller's imagination after a chance encounter with Dick King-Smith's children's novel, *The Sheep Pig*. As the director of the *Mad Max* trilogy and *The Witches of Eastwick*, Miller had demonstrated a keen visual sense and the ability to master effects. But with *Babe*, he would be reaching for new heights, both technically and artistically, especially if it was to be done in the way he envisioned: as a live-action film with adult, articulate animal voices mouthing uncompromising truths about Mother Nature, man and pork.

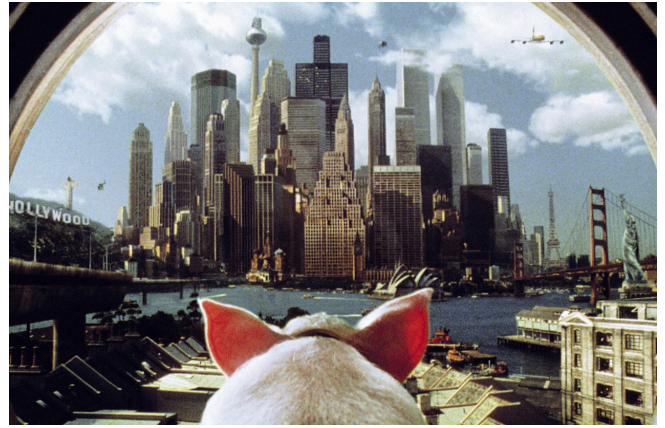
So ambitious was that vision, the film took ten years to achieve– but it proved worth the wait. *Babe* not only delighted audiences worldwide, it eventually corralled an estimated \$500 million in global theatrical and home video receipts. The Oscar for best visual effects was icing on the cake, and a tip of the hat both to the subtle artistry of *Rhythm & Hues'* digital lip-sync animation – which made live trained animals look as if they were talking – and Jim Henson's *Creature Shop* in London. “*Babe* was a landmark project at Henson's,” stated Oscar-winner Neal Scanlan, a twelve-year veteran of the company, now at the helm of his own animatronic effects facility at Elstree Studios. “*Babe* came under my supervision, because I'd had experience replicating real animals for features like *The Bear*. The idea of creating robotic facsimiles of furred animals was one of those things that people shied away from. It was a very difficult task.” *Babe* was also one of the first occasions in which animatronics were employed so extensively on location. With internal mechanisms and electronic engineering miniaturized to watchmaker's precision, the Henson Performance Recording System enabled an average of two puppeteers per character– one controlling the head, one controlling the body– to deliver a live on-set performance based on prerecorded moves.

Another of the techniques pioneered by the Henson *Creature Shop* for *Babe* was the use of silicone materials to create a more lightweight, translucent skin for the animatronic puppets. The use of a new material – something other than the standard foam latex – also posed new problems, however. Age-old techniques for patching, repairing, gluing and coloring puppet skins were suddenly obsolete, and new methods had to be developed and learned by the Henson crew.

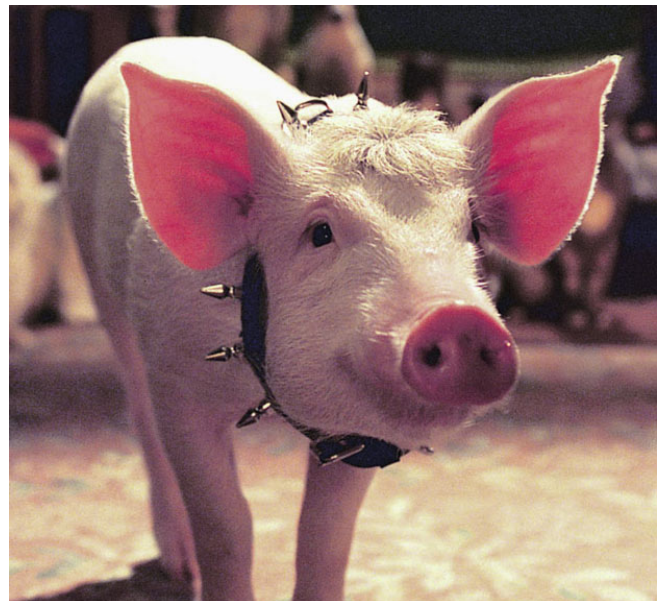
But all of that education and development was behind Scanlan and his crew by the time Babe's sequel – Babe: Pig in the City – came along. Considering the first film's boxoffice success, critical kudos and award nominations, the sequel had been all but preordained. Miller's new tale, co-written with Judy Morris and Mark Lamprell, extrapolated characters from the first without directly following King-Smith's books, and ventured further into a Brothers Grimm domain. Picking up after Babe and Farmer Hoggett's triumphant performance at the sheep-pig trials, the story segues to an incident on the farm in which Babe's curiosity leads him to fall into the Hoggett well, causing a hefty water pump contraption to plummet down and strike Hoggett. With 'the boss' laid up, Mrs. Hoggett finds herself confronted by mounting bills and an imminent foreclosure on the farm. As a possible solution, she elects to take Babe to a Grand State Fair to collect on an appearance fee that will wipe out their debts. Misadventure piles upon misadventure when an overzealous drug-sniffer dog leaves the travelers stranded in a teeming metropolis, until they chance upon the Flealands Hotel, an eccentric haven for lost souls, both animal and human. There, Babe encounters a family of performing chimps, their patrician orangutan, a choir of cats, an effete, aging canine duo, a paraplegic Jack Russell terrier, and other four-legged denizens of the streets. Babe's goodheartedness surfaces, even in the bowels of this urban hell; and when he saves the life of a pit bull that has been chasing him with murderous intent, the piglet is elevated to Numero Uno by his newfound friends, whom he eventually rescues from the city health authority.

Totally original, the story would pose both familiar and new problems to Miller and company. Not only were more animals featured throughout – especially in the movie's numerous crowd scenes – the level of performance would have to withstand a much more complex integration of live and simulated animal action. Greater realism would also be required to support lengthy, often poetic soliloquies of dialogue.

Like the first film, Pig in the City was produced in Australia; but for the live animal performances, Kennedy Miller Productions turned to American expertise. Karl Lewis Miller's Animal Action – based in San Fernando, north of Los Angeles – was



Babe, the lovable talking pig who captivated audiences worldwide in his first motion picture, returns in Babe: Pig in the City, a visual effects extravaganza directed by George Miller. The city in which Babe finds himself abandoned, a surreal amalgam of iconic international architecture, was represented via a digital matte painting created at Mill Film, one of several facilities engaged to meet the production's effects demands.



called upon to furnish and chaperone the real-life Babe and his animal companions, which this time would include a cavalcade of dogs and cats. For primates, Miller turned to Steve Martin's Working Wildlife in Frazier Park. Chimpanzees, capuchin monkeys and Mitra, a stately two-year-old orangutan loaned by the Singapore Zoological Gardens, filled out the eight-hundred-strong cast of live animals.

Much of the action, intricately choreographed, was performed on set by live trained animals. As with the earlier film, Rhythm & Hues used digital techniques to provide convincing lip-sync.

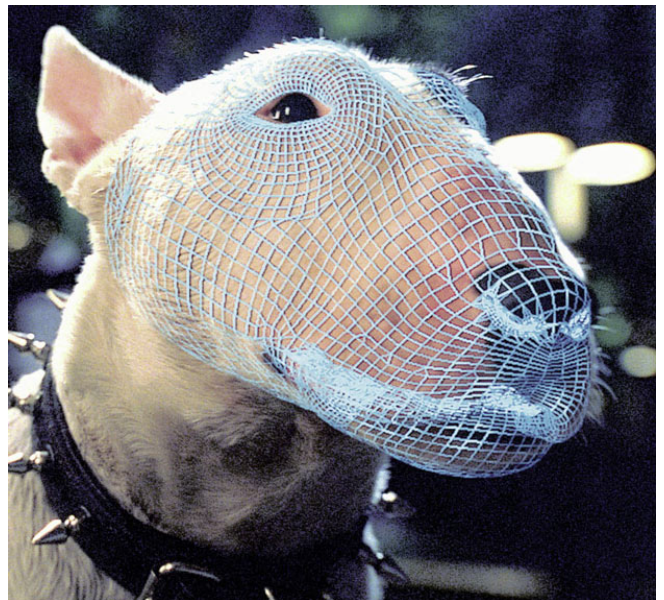
As in the first film, extensive animatronics and digital effects would be needed to complement that live animal cast. In an amicable parting with the Henson Creature Shop, Neal Scanlan stepped in to helm the animatronics assignment in Sydney, where the sequel would be filmed. And although Charles Gibson, Rhythm & Hues' Oscar-winning supervisor from the first film, was unavailable at the time Babe 2 went into production, Miller was still intent on going with the same digital effects house. Babe had been the biggest, most ambitious project in Rhythm & Hues' history; and yet, Babe 2 would almost double the assignment in terms of shot count. "The work was far more challenging than the first film," commented Bill Westenhofer, Gibson's successor, "but I didn't want to take on that many shots if it meant giving less attention to each one."

After some initial trepidation, Westenhofer assembled key staff from the first film to brainstorm an approach that would streamline the job. Eileen Jensen became lighting director, Nancy Kato was named animation director and Todd Shifflet became technical supervisor in charge of building a new pipeline, with Juan Luis Sanchez. Freelance visual effects producer Crystal Dowd completed the team. "George Miller chose to go back to Rhythm & Hues because of the quality of work they had achieved on the first film," stated Dowd. "But as great as the work was five years ago, we were absolutely intent on improving it."

Even before assigning the lip-sync animation to Rhythm & Hues, Miller had realized that an additional company would be required to provide digital effects beyond the centerpiece talking-animal work. In London, Neal Scanlan, accompanied by technical designer Ben Morris, instigated a search for the new player. "After scouring the Soho digital scene, we selected Mill Film," said Scanlan. "They had the knowledge and the enthusiasm."



Oftentimes, all facial features but the eyes were replaced with digital replicas that were animated, not like a human engaged in speech but in ways that seemed appropriate to the animal.



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Nine years of experience in producing digital effects for commercials and music videos lent the Mill Film artists their expertise; and their sophisticated, portable motion-control rig housed at Shepperton Studios cinched the deal. "It was our first major feature, and certainly our biggest," recalled company visual effects supervisor Grahame Andrew. "The nice thing was the variety. Out of 105 shots, there were thirty different types of effects: talking animals, bluescreens, greenscreens, multi-animal shots, motion control, matching live animals with full 3-D animals, complicated split-screens- just about every visual effect you could imagine."

Much later in production, a final facility would join the team: Animal Logic Film, a Sydney digital effects house that had also been associated with the original film. "When we started off, we were just going to do a few shots," commented Animal Logic visual effects supervisor Chris Godfrey. "But it grew and grew." While Mill Film would handle compositing and motion control, Animal Logic picked up everything else- from simple split-screens to wire removals and some incredibly difficult chroma-key material. "We also ended up doing a lot of integration work between the houses, and actually setting up a facility inside Kennedy Miller. A lot of compositing work was done on-site to enable George to oversee and review the work."

As the visual effects team took shape in the late winter months of 1996, Scanlan's animatronic build commenced in Sydney. But first, the effects crew had to determine which shots would require real animals and which would require animatronic versions. "The first point in any discussion concerning whether we should use a real animal or an animatronic was safety," Scanlan revealed. "Were we asking the animals to do something that was dangerous to them? The second consideration was performance. Could the real animal perform in the way that the director wished? Ferdinand the duck, for example, was such a manic character, not only did he need to perform accurately, he also had to have a tremendous amount of attitude. It just was not possible to get that level of performance out of a real duck in



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a closeup or medium shot. As a guide, whenever you see Ferdy walking around in a wide shot, that's real; otherwise, he's an animatronic. Similarly, pigs don't like lying still; so the scene in which Babe is hungry and lying on his side with his belly wobbling required an animatronic."

The final consideration was animal sociability – some animals simply could not work together, despite the film's message of interspecies harmony. Where a split-screen was not possible, animatronics were substituted, as in a scene that placed Babe and a group of his friends inside an open elevator. "We had a whole mix-and-match of live and animatronic characters in there," related Scanlan. "Babe, Ferdy and the baby chimps were animatronic, and the real animals were on either side, flanking this natural barrier, positioned so they could see their trainers. You couldn't have put fifteen real animals in that space without mayhem breaking out." The animatronic build list included multiple versions of sixteen types of animal: twelve Babes, six ducks, three chimpanzees, six baby chimps, a capuchin, an orangutan, two Jack Russells, one Doberman, one pit bull, seven mice, one pelican, several goldfish, cats, pigeons and six refurbished sheep from the original film, supplied by John Cox's Creature Shop and RoboTechnology.

Early in 1997, Scanlan and his technical team – Anton Boniface, Ben Morris and James O'Connor– also began building a new performance animation control system – the PAC – with a company called Hepworth & Hatcher. "Julian Hepworth and Paul Hatcher were software and hardware designers involved with computerized control," stated Scanlan. "They were great to work with because they had no preconceptions of the kind of system we were building." A refinement of the system employed on Babe, the PAC featured right-hand/left-hand input devices flanking a laptop computer atop a docking station. Software was developed with Adrian Hill, a leading programmer at Softimage, who created an animation program specific to the animatronic performer's needs.

The system, like its predecessor, was based on the interaction of servo mechanisms with a prerecorded dialogue track, allowing live puppeteering to be combined with a subtle tweaking process known as curve editing. "Every scene with talking animatronics was preprogrammed before shooting, as far as the dialogue was concerned," explained Scanlan. "It's a bit like key-frame animation in the sense that you try to make phonetics hit the major points of movement, while operating a puppet in real time. The PAC records that information and displays the movements of each motor on a time curve– where it peaks, where it drops, when it's stationary. By playing that back and watching the animatronic to see where the sync is not precise, you can go back and literally grab the curve and move it higher or



As the live animal performers were sometimes incompatible, and often had acting agendas of their own, it was impossible to stage large group scenes on set. If more than three or four animals were in a given shot, multiple elements– often dozens of them– were required. Animal Logic assembled many of these complex composites.

lower, advance or retard it, until each little individual motor in the puppet works with the track.”

Spring 1997 found twenty artists and technicians, many of them longtime associates of Scanlan, leaving London to establish what would become a seventy-person contingent, British and Australian, at the Neal Scanlan Studio in Sydney. Over the next five months of preproduction, Scanlan was joined by representatives of the digital effects team, including Grahame Andrew and motion control cameraman Malcolm Wooldridge. Initial preproduction tasks included previsualizing key sequences. “We did quite a bit of previsualization,” said Andrew, “and we built the interior of the Flealands Hotel in Softimage to help us choose camera angles. The art department also found it very useful for storyboarding; and it helped them build the sets.”

Mill Film’s previsualization duties extended to planning complicated animatronic sequences. “Grahame and two of his animators spent some time with us looking at moments in the film that required the input of not only ourselves, but of Mill Film or Rhythm & Hues,” explained Scanlan. “We put animatics together with very simple CG models and composited shots with temporary background plates to give George some idea of what the final composition would look like. We also made some little animatronic puppets on sticks and shot them live.” One such early test depicted a flock of flying pelicans encountered by Ferdinand the duck, who suffers a series of airborne mishaps as he follows Babe to the city. “The pelican scenes were all to be shot with motion control. We made twenty little pelicans on sticks, foam castings without feathers, each about a foot across, and each held by one operator. We choreographed these to find the beat of the wings and the motion of their bodies, and at the same time figured out the motion control move. That way we could shoot our birds as bluescreen elements without being forced to wait for the sky plates to be shot.”

The Rhythm & Hues team also visited the production prior to the shoot to discuss digital effects requirements. “The most amazing thing we learned on the first film,” recalled Eileen Jensen, “was that the perception of the animation was completely dependent on the textures surrounding it. On the first film we made incredibly detailed 3-D models of the animals, only to learn that the actual model didn’t have to be all that detailed because the details came from projecting the texture onto it. The hinge points for the jaw and the eye distance all had to be correct so the match-move department could place the model in 3-D space; but once the film frame was projected over it, the gray-shaded model became invisible.”

Having established texture projection as the key to the illusion, the challenge lay in streamlining tracking methodology. “We took our proprietary software and put in additional hooks to help us see textures in the animation stage before rendering,” Westenhofer stated. “The process of hand-tracking, despite all our technological advances, was still the only way we could accomplish this. We spent a lot of time coming up with tools that would help the trackers fit the rigid model to the real animal, then go back to animate the malleable parts of a character’s face.”

Traditional CG modeling techniques- taking physical measurements of the live animals and their animatronic counterparts and working from photo-reference- were assisted by a new proprietary tool, dubbed the Geometer. "We had a 3-D camera setup," Westenhofer noted. "Two cameras took simultaneous scans that we could then check against the final model, so we could make adjustments to the models in 3-D space. When you viewed the two images side by side on the monitor screen, you could isolate a feature in the left or right window and the computer would calculate the depth by triangulation."

As Rhythm & Hues tested new techniques, an animatronic rehearsal phase was underway in Sydney. "When the animatronics were ready," recalled Scanlan, "we began rehearsals to help the people who would operate the characters become intimately acquainted with their capabilities." With storyboards and video of live animals for reference, the Scanlan crew videotaped rehearsals and analyzed performance and camera angles with George Miller. "We were able to prepare each scene so that we understood its emotional content. George would first explore what was possible, often taking us slightly further than we should go. Then he'd pull us back and pinpoint what he wanted, working with the characters as he would an actor."

Principal photography for *Pig in the City* began September 1997, at the Fox Studios in Sydney, where sets such as the centerpiece hotel were built. To enhance the film's enchanted, storybook feel, the sets were built at three-quarter scale, and were elevated and reinforced to support Mill Film's Milo motion control rig- a Mark Roberts arm, supporting a Mitchell S35 camera running from Flair software. The rig would be utilized to shoot repeatable camera moves on live creatures to build up large crowds of animals - an approach that had been attempted, unsuccessfully, in the first film, but which would be retried for five shots in the sequel. "The rig breaks down into seven or eight pieces, so it's very portable," Wooldridge observed. "Fully assembled, it weighs about three-quarters of a ton. It has to be sturdy because it's a live-action rig and we are often out on location, crashing it around. Sometimes fitting into the sets was difficult, but the Australian construction team that worked with us was brilliant. We could strike and be ready for the next shot within an hour."

Once on the set, measures were taken to minimize the length of time spent dealing with the live animals. In fact, the unpredictable nature of live animals prompted Scanlan and his crew to create nonarticulated 'photo double' puppets for each of the main animal performers. Made only to eighty-five percent cosmetic level, these stand-ins were nevertheless close enough to their live counterparts for lighting and other purposes. "They were never used to deliver dialogue," Scanlan noted, "but they could be used as foreground elements for over-the-shoulder shots, and they saved time wrangling animals for some shots."



Mill Film contributed shots of a cat chorus that featured several live animals in the foreground- with digital lip sync- augmented by dozens of computer generated extras in the rear.

With lighting locked down, trainers would then bring in live animal performers in workable groups, generally one trainer per animal. Miller would convey his wishes to the trainers and then attempt to achieve a performance in sync with dialogue playback. “Body language and eye-lines were critical, since we weren’t animating either of those,” noted Westenhofer. “I would sit behind George, view the action as it played and get a feel for whether we had a moment that really fit with the track and the character we were trying to portray.” Long before filming began, the Rhythm & Hues team members had familiarized themselves with all of the animal characters through long discussions with Miller. “We went over each of the characters with George, establishing what their individual personalities were so we’d know what we were looking for in the on-set performances.”

The single most complex character, in both digitally-enhanced and animatronic versions, was Babe. The trip to the city subjected the piglet to a whole range of physical and emotional torments, including fire and water, acrobatics and falls, high-speed pursuits and narrow escapes. Even the live pig requirements were daunting. For Babe alone, production employed more than a hundred Large White Yorkshire piglets, aged thirteen to sixteen weeks, with groups of six replaced every three weeks as they outgrew the role.

The animatronic approach to the title pig followed the same pattern developed five years earlier, although iterations were far more complex for the sequel. Basic Babe action was first broken down into a range of modular silicone puppets, captured in a midway pose to facilitate a greater range of articulation and emotion. These were then supplemented by others with specific capabilities dictated by the script. “We had a standing pig that could move as if he were about to sit,” Scanlan explained, “but he would never truly sit down because of the constraints of the silicone. There were also sitting versions and lying versions.” Four articulated heads, six connecting necks and ten versions of the body were produced for the basic Babe kit.

“The main Babe was sculpted by Jeremy Hunt, who also worked on the first film,” stated Scanlan. “One of the great things about *Pig in the City*, for us, was that Babe wore a collar. In the first movie, each night before the shoot, we would attach the head to its relative body and apply a prosthetic silicone band around the neck where the head joined. This would then be hair-punched to disguise the blend. It was very important that we knew on a day-to-day basis what versions of pig were required, because we couldn’t instantly remove the head and place it onto a different version. The collar on this film hid the join, which was a tremendous bonus.” Jason Reed built the highly-mechanized heads – as he had for the first film – and maintained them through almost constant and simultaneous use by two units. Engineer John Vanderpool mechanized the bodies,



Animatronic puppets– by Neal Scanlan Studio– were created for nearly every animal character in the film. For a scene in which Ferdinand the duck tries to follow the plane carrying his friend Babe to the big city, a duck and a pelican– made into a flock by multiple motion control passes– were shot against a bluescreen and composited into aerial plate photography by Mill Film.

silicone technician Simon Clutterbuck and lead mold-maker Barry Fowler produced the skins, and Victoria Stockwell returned to lead the hair-punching crew.

A robotic version of the pig- known as 'Pump Babe'- was designed for shots of Babe descending Hoggett's well atop the falling pump. The sequence sometimes intercut live and CG pigs to deliberately disguise the illusion. "Obviously you could shoot a lot of these sequences in many different ways," noted Scanlan, "'but we tried to keep people guessing by mixing them constantly. There wasn't an obvious pattern people could pick up on.'" Another case in point was 'Forgiven Babe,' employed in the scene following Hoggett's accident. "George wanted the pig to have a very hound-dog look. The live pig was always active, so we built an animatronic to give us that quiet, sedate body language."

Babe was actuated through the floor of the set, which was raised five feet off the ground- a workable height for two seated puppeteers. Cables were fed to the PAC through the pig's legs, which were also used to manipulate rod controls. "By attaching a rod to one of the front or back legs, we were able to effect the body language of the pig, and the rest of the mechanical skeleton would follow suit," said Scanlan. "In a sequence like this, he was operated by cable-control, one person performing the head through the control system, another performing gross body moves by rod."

A more portable robotic Babe was swaddled in a blanket for a scene in which the beleaguered Mrs. Hoggett sits stranded at the teeming city airport. "That was a specifically designed sculpt," Scanlan commented, "self-contained so it could wriggle." Dubbed 'Curly Babe,' the silicone pig was sculpted by Jo Thompson, with mechanisms designed by Aiden O'Keefe. Richard Coombs preprogrammed the puppet to kick and bounce, then operated it on location via radio control.

Other animatronic versions of the pig included 'Hungry Babe,' a prostrate porker with a distended, growling stomach; 'Swimming Babe,' a pneumatic puppet operated underwater from a submerged raft containing valve and servo mechanisms - and employed for a scene in which Babe rescues the pit bull from drowning; and 'Hanging Babe,' another radio-controlled puppet, dangled from a window. Featured in the hotel raid, Hanging Babe contained a mechanism linked to an umbilical that facilitated kicking legs, a twisting body, moving head, facial articulation and eye blinks. The pig-on-a-stick was rigged by special effects supervisor Tad Pride's department to a braking system that took the force of the heavy animatronic as it dropped from the window, while the dog-catcher performer clung on to the other end. Animal Logic later removed umbilicals and rigging.

Scanlan's most ambitious pig was 'Motion-base Babe,' an innovation that applied motion capture and curve editing to a walking, talking animatronic. "Motion-base Babe was driven by hydraulics, with mechanisms housed in his body," stated Scanlan. "Karl Miller trained a pig to walk, then trot, then run on a treadmill. We motion-captured those movements, then loaded that data into our PAC and asked the hydraulic pig to perform in a walking mode. We then went back and curve-edited some of those movements, softening them, putting more character into the walk, swaying the hips a little to tailor it to the scene. It was a terrific starting point for a

performance. Instead of worrying about Babe physically moving, the puppeteer could concentrate on the character's attitude."

Originally developed for a scene in which Babe is chased around the canal by the pit bull and the Doberman, Motion-base Babe was rendered less visible due to editorial changes. "You see him from the rear just prior to that scene, as he's following the chimps when they go to raid the store," Scanlan remarked. "He's got a bit of a swagger, like Marilyn Monroe." Diminished screen time notwithstanding, Scanlan was encouraged by the results. "I think it's a very important development, something that we will return to on future projects."

The most controversial scene in *Pig in the City*, and a pivotal story point, occurs at the climax of the dog chase. The pit bull, trailing a chain tangled with a lawnmower, pursues Babe across a bridge, lunges for the pig and falls head-first into the canal. The chain snags and there he hangs, horrifically, with his head submerged in the water, until Babe saves him. The pit bull was a cable-operated puppet, sculpted by Ray Scott, mechanized by Guy Stevens with Reed and Roberts, who also produced a hand-operated snapping version for the sequence. Foam latex and polyurethane skins were created for the full-body dog, with more durable foam used in areas of gross movement. Mill Film removed cables supporting the dog from the bridge, while, alternately, a live pig and Swimming Babe nudged a rowboat to rescue the drowning dog.

One of Miller's personal additions to the original King-Smith book was Babe's sidekick, Ferdinand the duck. Two versions of the bird were sculpted for the sequel by Esteban Mendoza and feathered by Val Jones. Tim Jordan mechanized closeup and full-body versions of Ferdy in his upright stance, both employing Scanlan's trademark Spiney- a cable-controlled vertebrae mechanism developed for *Little Shop of Horrors*- to actuate the duck's thin but always active neck. Wings were rod- or wire-operated, while eyes, beak and tongue were cable-controlled through the Spiney. Bladders in the neck enabled the duck to swallow.

Greg McKee mechanized flying versions of the duck with kicking legs and an internal flapping wing mechanism, shot in real-time against bluescreen by Mill Film. Overtaken by the 'fat featherless flying thing' carrying his lucky pig away- one of several 3-D jet airliners generated at Mill Film by Ivor Middleton- the exasperated duck finds himself flying alongside a graceful pelican. Sculpted by Ray Scott, mechanized by McKee and Vincent Abbott, and feathered by Jones and Sarah Brunson, the single pelican became a flock by shooting repeat motion control passes against bluescreen, based on choreography derived from earlier animatics and the mathematical assistance of film editor Jay Friedkin juggling elements on the Avid. "We defined how many pelicans there should be in the scene, then went around the clock, offsetting the motion control camera each time," Scanlan recalled. "At the same time, we changed the look of the pelican. If you look very closely, you'll see they have different color eye patches, different shadings on their wings, all using the same animatronic."

Thirty motion control elements were multiplied to eighty by Mill Film 2-D supervisor Karl Mooney, who also performed some crucial finessing. "We stabilized the background helicopter footage and dropped some lovely plates of the sea into the misty holes in the clouds," stated Mooney. "We graded the sky, put some shading in it, then replicated the birds, put them out of sync, and cleaned up all the wires and rods in our Matadors."

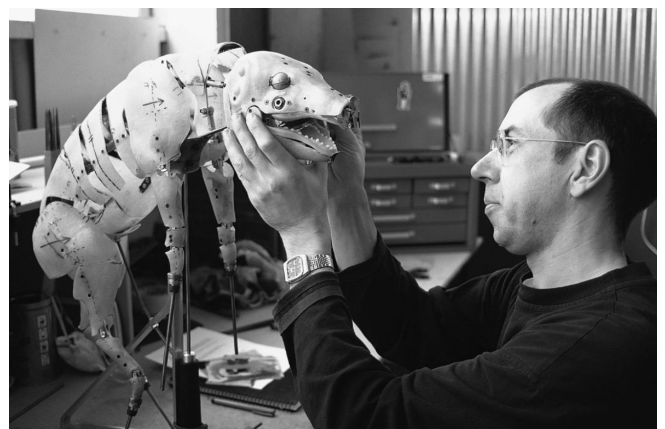
A live duck was incorporated into a later pelican scene for Ferdy's arrival high over the city. The duck was trained to sit in the animatronic pelican's bill by introducing the animal incrementally to first a mockup fiberglass beak, progressing to a silicone bag, then a bag raised over the ground, then a bag over the ground with a wind fan. "It was a very slow process to get the duck comfortable in that situation," observed Scanlan. "When he's in the bill and flutters out, that's the real Ferdy; when he comes back up into frame, that's animatronic."

Animal Logic played a role in scenes involving Ferdy's arrival and departure at the Flealands Hotel. Both instances posed the problem of how to fly a duck through an empty real-time plate. Ferdy's arrival through a skylight, coinciding with the city health department raid on the hotel, had him burst over camera, landing past a balustrade high above the atrium. The distance was too steep to throw the real duck, but no one had the time to animate a 3-D version. "We determined the best thing to do was to use the balustrade as a cutting point and fly Ferdy over camera as an animatronic later," Chris Godfrey related. "We generated a quick mockup for George, and got a lock-off on our plate." The Scanlan crew rehearsed a puppet Ferdinand against bluescreen, copying a simple, shaded 3-D model duck against the background plate. Within fifteen takes they matched the action. The final move was timed and composited into place, the animatronic wiping out of the shot at the balustrade, where the live Ferdy entered in a flapping flurry, thrown in from a safe distance. Ferdy's exit also required an empty plate, a slow craning move on a night exterior of the hotel set. Animal Logic tracked the shot, adding a temporary 3-D duck with a simplified flap cycle. Scanlan puppeteers then matched the move.

Nowhere in the production were the tracking and layering of live plates put to more spectacular effect than in Mill Film's centerpiece motion control shots. After winning over the pit bull, Babe returns to the Flealands Hotel to oversee the distribution of booty from the chimpanzees' convenience store raid. In one continuous sweep-lasting a full thirty seconds- the camera glides down from a second-story landing, tracing the stairs, passing scores of cats, dogs, kittens, pups, chimps and mice, all in line and moving forward to arrive at the capuchin, who hands each a jellybean. The shot was broken down into fifty motion control passes, isolating groups of animals,



Animation supervisor Nancy Kato and visual effects supervisor Bill Westenhofer examine a chimpanzee facial maquette at Rhythm & Hues.



Neal Scanlan Studio technician Chris O'Dwyer fits mechanisms into place on one of the many Babe puppets created for the film.

sometimes individuals, with movement for each cued by time-code to prevent post-composite collisions. "We had to accurately record each group of animals to build up the shot as we went along," related Wooldridge, "otherwise one of the animals could have been walking into the back of the animal in front of it. The animals were also being shot at different speeds to effect their performance, so we had to trigger them at different speeds and play them back in sync."

Faster film speeds were sometimes used to slow down movement of the live piglet's bobbing head. If the animal was shot at 36 frames per second, the sound department would have to trigger dialogue accordingly. This was particularly important in another motion control setup following the jelly bean communion, in which Babe gives his blessing in the form of an impromptu rendition of Farmer Hoggett's anthem, "If I Had Words." The complete assembly of animals joins in, the camera tilting up to give a grand view of the choir filling the atrium, a shot that incorporated two hundred motion control passes.

Rough composites were assembled from select takes by Jay Friedkin on the Avid, then sent to Mill Film editor Jody Rogers via a secured link on the Internet. Mill producer Martin Hobbs shepherded operations in London, while Karl Mooney oversaw the compositing. "Jody would create lineup sheets from the Avid composites," recalled Mooney. "We would grab all of those layers on the Infernos, sync the plates up, do a very rough test composite of our own, and then start pulling mattes on the Matadors. We used another Flame for help with the difference matting and the painting, but you can still never get all of that data on one machine. I had to split the shots in two and, once all the layers had been composited, put them back into one machine, then run them through the Matadors for a final check." Once the plates were in, the shot took a month to complete. Animal trainers and animal foot-markers on the studio floor all had to be painted out in addition to the actual compositing.

The art of individually triggering and tracking live animals to move in concert with each other was taken to another level during a later location shoot, inaccessible to motion control. Liberating his captured friends from the city hospital, Babe leads the way to freedom across a drainpipe bridging two tall buildings. The camera slowly craned and tilted until it was looking down over the parade of animals, more than a hundred feet above a parking lot. "I like to enable filmmakers to do the shots they want to do, rather than dictate that to them," Grahame Andrew observed. "One tool we developed enabled us to match any camera move by tracking background plates. We could shoot background plates with any camera, then match that move in our 3-D system, transfer that data into our motion control rig, and shoot foreground elements to go with that."

Andrew attended the night shoot at a Sydney hospital, taking notes with only a tape measure and two reference crosses on the empty pipe. "The camera was on a crane on top of a scissor-lift with a remote head," Andrew commented. "There was no encoding- it was a totally free, hand-operated camera." The drainpipe that bridged the gap was designed by production designer Roger Ford to be marginally smaller than the final pipe to be laid over in post. Once the shot was locked, then tracked in London, a motion control shoot ensued back at Fox Studios using live animals on a greenscreen replica of the set, with the pipe this time four feet above a heavily padded floor. "We did three hundred takes on the motion control rig, because there were thirty animals, ten takes each. First we shot the pig, then the duck and the capuchin, then

the chimps and dogs, and finally the orangutan. We made sure that every animal stayed in sync, so they wouldn't crash into each other, but we also tried to get them fairly close. The bulldog's nose was right up the chimp's butt, but not quite."

The final shot, some thirty-five seconds long, provided challenges for the 2-D department, since different animals required different surfaces on which to walk. "Babe had some mesh over the tube so that his trotters had something to grab to," said Mooney, "but then the dog wouldn't walk on that mesh, so they had to change it. Every one of those animals was hand-painted and matted off its background because of the different pipe textures. We also had to make new shadows to situate them in the beauty pass of the empty pipe. It was probably the most difficult shot we worked on."

Babe's earlier chase also incorporated dynamic motion control moves as the camera tracked him through a junkyard, outrunning the dogs and an avalanche of junk. Shadow passes, junk passes and clean passes were filmed in seven layers, all based on an essentially live move in which the camera operator overrode a programmed move in order to hold frame on the darting pig. Manual override also proved a boon in finding final frame on the jelly bean communion, as well as in composing simpler split-screen composite setups with tired or restless animals. The final motion control shot count for Mill Film rose to twenty- four times the original plan- filmed over twelve weeks.

More traditional use of the Milo motion control rig was for scenes of the lonely pig pondering the vast metropolis through an attic window in the Flealands Hotel. The city is revealed as the motion control camera pushes in over the pig's head to gaze with him out a small, round window. A surreal amalgam of iconic landmarks stretches out before him- Big Ben, the Eiffel Tower, the Sydney Opera House, the Golden Gate Bridge, Saint Peter's Basilica, the Statue of Liberty, the Hollywood sign- a storybook city that is all cities.

The move was established by Mill Film's motion control camera on a rooftop overlooking the real Sydney harbor, timed to capture as much real boat traffic as possible. Freelance matte artist Michele Moen, in Los Angeles, generated a painting from the plate, guided by the storyboards and used as a basis to create a 3-D model in the computer. The painting was then digitally projected onto the model and brought to life with detail. "We added 3-D helicopters, pelicans, vehicles on bridges, a monorail, flags," said Andrew. "Only the water and the boats were real." The city was composited with a greenscreen element of a live pig at a mockup window, his attention rapt on an animal trainer in a green suit. The greenscreen element was then combined with a beauty pass of the actual set, shot with the same preprogrammed push in.

A nighttime version of Babe's city view- with flashing lights, neon signs and fireworks- was also produced for a later scene, accompanied by Scanlan's animatronic mice singing "Are You Lonesome Tonight?" Sculpted by Nigel Booth and engineered by Jim Sandys and Thomas Vankoereven, each mouse featured forty points of movement, supplied by externally housed servos that were digitally extracted. A closer view of the metropolis at dusk was created for a scene of newly-arrived Ferdy resting in the arms of a stone angel high atop a skyscraper. Originally planned as a motion control move, the shot was ultimately tracked left-to-right across

a 3-D matte painting, aided by a perspective shift in the moving clouds, to arrive at the live bird and building element, shot on a Hybrid dolly.

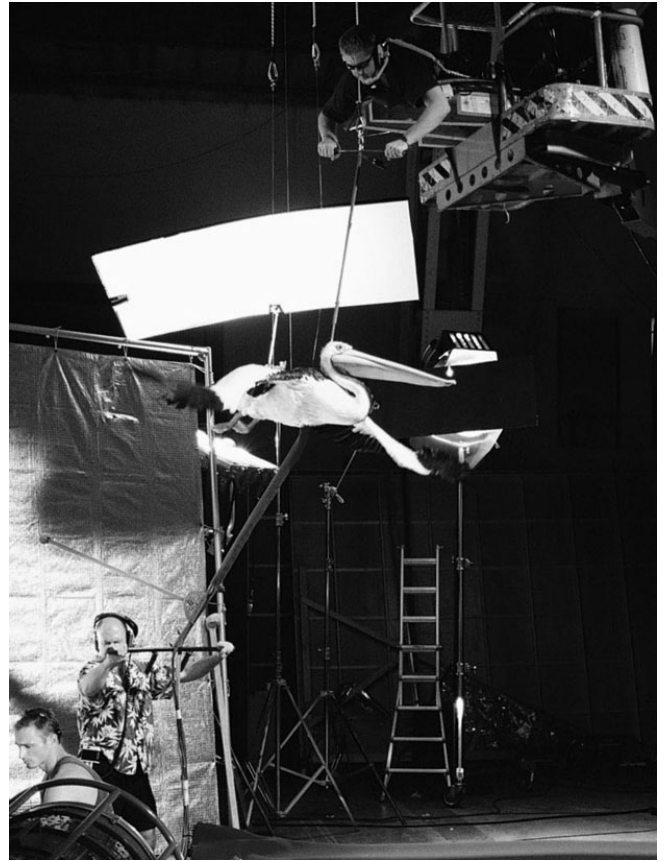
In an interlude occurring before the onslaught of the city health authority, Zootie the chimp softly complains of a pain in her swollen belly. The film then cuts to a tableau of animal onlookers gathered around the hotel fireplace, watching as Zootie cradles two tiny newborn chimps. Sculpted by Booth, mechanized by Abbott and furred by Jeni Walker, the babies were another animatronic marvel, linked via the PAC to two external blocks of servos, controlling nearly sixty points of movement in the twelve-inch puppets. The characters could emote and move their feet and hands; but Scanlan had reservations about their eyes, since the tiny puppets would be seen so close. "There comes a point where I believe, mechanically, you can't make eyes look real," said Scanlan. "The eyes are, after all, the windows to your soul. We built the animatronic with wide-open eyes; Animal Logic photographed the real Zootie's eyes under the right lighting conditions, and they composited these with eye-blinks into our animatronic babies. So Zootie's babies really had their mother's eyes."

Adaptive technology was not always so sublime. One sequence involved Flealick D'Wheels, a fearless Jack Russell with dysfunctional hind legs, being towed behind a speeding truck. An animatronic was created, allowing the little dog to hold on perilously with his teeth, front legs elevated off the road, back legs housed in his paraplegic trolley. Sculpted by Scott, mechanized by Andrew Roberts, with flocked fur applied by Mendoza and Stockwell, the animatronic dog was capable of radio-control snarl, neck wriggle, front paw kick and saliva emission via a connecting rod that fed through the truck chassis to two operators within. When the script called for Flealick to lose his grip and careen to a crashing stop, Miller wanted Flealick to bounce, then come to rest at a specific point during a Hothead camera move. Animal Logic supervisor Godfrey came up with a solution. "We had a close look at the replay and found the dog was going in and out of shadows as it was rolling," Godfrey noted. "Neal and I picked the spot where Flealick had to hit and we decided to match cut. The Libra III camera wasn't motion-controlled; but it had memory, so we shot our base shot, then a clean plate in case we needed it, then the rolling dog. As soon as Flealick went into the dark, we tracked the new shot into it. It gave us the perfect roll, then flopped at exactly the right spot. Neal does beautiful ten-pin bowling with animatronic dogs."

A long postproduction followed principal photography, and it was during this phase that Rhythm & Hues completed the majority of its lip-sync animation shots. The first shot to be fed through the pipeline began as a test and ended up as a benchmark for animation standards throughout the production. "The first shot we got back was of Zootie the chimp opening the door when she meets the pig for the first time," recalled Bill Westenhofer. "Nancy Kato began by playing around with how we wanted to lip-sync a chimp. We couldn't just take the way a human forms a word and plug that into a chimp- they've got such big, floppy muzzles, it didn't look right."

After a great deal of experimentation, including custom jaw work to make Zootie chew and blow an animated bubble-gum bubble, Kato strove to maintain the style of animation set up by the first film, manipulating cheeks, lips, eyebrows and eyelids, but avoiding the eyes. "On the first film we thought we could replace the eyeballs," said Eileen Jensen, "but we found we couldn't catch the life that was in the original eyes. You can do little tricks to change eye direction with

highlights; but when we completely replaced the sheepdog's eyes, for example, the poor animal ended up with these black, bottomless pools. For the trick to work, we replaced the heads only below the eyes or around the eyes – such as the eyebrows. We replaced as small an area as possible; and then texture painters recreated mouth interiors.”



Scanlan puppeteers Sean Masters and Phill Woodfine operate the pelican during a shoot at Mill Film.

Once into the actual animation, the digital artists took care to avoid behaviors and mannerisms that were cartoonlike. “Perhaps the only liberty we took was to make the eyebrows a bit more mobile than a real chimp’s,” Westenhofer noted, “but we tried to find a balance that didn’t look out of the ordinary.” Most of the animation effort was centered on the lip-sync. As reference, video had been taken of the human performers voicing the dialogue track; but Westenhofer and Nancy Kato quickly discarded this as misleading. The animators discovered – as had their predecessors on the first film – that the different physical characteristics in the animals precluded them from mimicking human mouth movements. Ultimately, the appropriate lip movements were developed shot by shot, through trial and error. “We would track the shots, think we had a preliminary animation and show a test to George, who would offer comments,” noted Crystal Dowd. “Then, as we perfected the lighting and added fur to the mouths, sync issues would continue. It was incredibly meticulous.”



Character sculptor Ray Scott at work on the hanging pit bull.

A twenty-person match-move department, led by David Sudd and Stephen Dobbs, tracked the live-action plates. Three-dimensional models were then applied and controls were added to move the jaw and areas of sympathetic movement– in the case of the chimps, seventy points of movement were provided in the head. Nancy Kato’s team of fifteen animators, led by Keith Roberts and Eric de Boer, then adjusted to the track. Eileen Jensen’s twenty-three lighting artists, led by Mary Lynn Machado and Betsy Asher Hall, worked in tandem with the animation department, painting and adding textures. The completed shot was finally rendered and tested on the Avid against the track, downloaded from Australia by effects editor Michael Backauskas. Depending on their complexity, single lip-sync shots could take anywhere from two weeks to five months to lock.

Roberts and de Boer proved the most adept at primate sync, along with Ian Hulbert and Glenn Ramos. Roberts, as Zootie specialist, was entrusted with a scene in which a chagrined Babe begs his new chimpanzee friends for compensation after a disastrous attempt at joining in their children’s magic act. “Zootie was right up to camera, so we had to be really inventive with her mouth shape,” Westenhofer remarked. “We actually added some interactive lighting on the muzzle so you wouldn’t see a texture moving around. Also, because it was a closeup, CG hair just didn’t hold up; so we cut a strip from Zootie’s original fur, formed it to follow the animation, then laid CG hair on top of that, cementing it to the chin.”

Additional digital animal work was ongoing at Mill Film. For one shot, the company proved that pigs could fly by providing four 3-D pigs for tumbling and falling scenes. After editorial rethinking, four shots were reduced to two– one featured in the crash-landing into Hoggett’s well, the second for a splashdown into the canal during the pig-and-pit-bull chase outside the hotel. Both falling shots began with an animatronic stand-in. “The puppet gave us a lighting and texture reference,” stated Grahame Andrew, “and it also gave us a splash; but it was very static. We then went in and composited our 3-D pig over that, giving him a beautiful texture and animating kick and wiggle.” The canal fall pig was generated by Andrew himself in Softimage, rendered in RenderMan and composited in Flame by Simon Stanley Clamp.

Fifty-four feline 3-D characters were also supplied by Mill Film for scenes behind a mysteriously locked door at the Flealands Hotel. Investigating a curious noise, the singing mice discover, to their horror, a competing choir of cats filling every corner of the room. Front-row singers were live, given lip-sync animation, while the main body of the choir was modeled from scratch, based on photo reference of live animal performers. A final animatronic touch was applied to the rear end of the conductor cat– a live animal trained to sit upright in a tiny furry seat to which was attached a weighted, wire-manipulated, swishing tail.

Mill Film also supplied animation for Thelonius, the saturnine orangutan. A major presence in the film, Thelonius broods over Babe’s arrival at Flealands with a world-weary countenance. Supervising animator Alison Leaf spent four months in Sydney observing her orangutan star before returning to London to develop animation of a 3-D muzzle that would complement the ape’s subtle performance. “Interiors of the mouth were generated separately,” commented Andrew. “Although all these elements were generated in 3-D, we did most of our composites in 2-D. Karl Mooney assembled the final shots so we could control the brightness of the teeth, make them appear backlit, make tongues pinker, shinier, darker.” Muzzle textures were applied via Mill Film’s proprietary Chameleon program, while the blend with the real ape’s face was disguised by individual 3-D hairs.

Beyond all the takes, beyond all the tricks employed, the magic of the movie came down to one criterion– performance. “What we really wanted to do,” concluded Bill Westenhofer, “was make you believe that these were no longer animals performing, but that they were people, almost actors. We wanted you to forget they were visual effects. We deliberately toned down lighting inside the mouth to draw your attention away from the animation and draw it back to the eyes, to focus on trying to give a natural, believable performance.”

The film had been a remarkably harmonious meeting of creative minds, despite the physical distances between them, because all had been united towards that common goal. “Pig in the City was a fantastic jelling of All Effects techniques,” Neal Scanlan observed. “What was great this time around was that the digital world had become encompassed into the overall design. The audience is remarkably quick at becoming accustomed to the look of specific effects, be they digital or animatronic, so you have to keep pushing the boundaries, trying to find something new. As long as we do that, we’ll all have a place within the film industry. The future lies in the marriage of techniques.”

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Production still photography by Carolyn Johns and Sam Forster. Additional photos courtesy of Neal Scanlan Studio, Rhythm & Hues and Mill Film. Special thanks to Bette Einbinder, Suzanne Datz and Katie Newitt.

WING COMMANDER SPACE ACE ENGAGEMENT

article by Kevin H. Martin

Space warfare has been a staple in science fiction literature since the era of pulp magazines, but with relatively few exceptions- most notably the Star Wars and Star Trek films- motion pictures have steered well clear of this subject matter. In recent years, only *Aliens* and *Starship Troopers* have chosen to explore the subgenre. *Aliens* related thematically to America's involvement in Vietnam, with technology-dependent marines being routed by essentially unarmed foes, while *Starship Troopers* embraced an openly fascist government's defense of earth against monstrous bugs. Eschewing such political fare, the Fox Filmed Entertainment release of *Wing Commander*- replete with elaborate combat scenarios, armadas of aircraft-carrier-like capital vessels and swarms of fighter spacecraft- elected to evoke the feel and sensibilities of a World War II naval epic.

Wing Commander first took flight a decade ago as a CD-ROM computer game created by Chris Roberts, who would ultimately take the reins of the feature film as well. The interactive first-person adventure, released by Origin Systems, followed the exploits of young Confederation lieutenant Chris Blair as he dueled in his fighter spaceship against a catlike alien menace called the Kilrathi- a storyline that would be retained for the motion picture years later. The first two *Wing Commander* games featured animated characters; but with the 1994 release of *Wing Commander III: Heart of the Tiger*, computer gaming evolved further, incorporating live-action video segments. After Origin was acquired by Electronic Arts, Roberts' next *Wing Commander* entry continued the cutting-edge nature of the series, becoming the first computer game to include 35mm live-action. More recently, *Wing Commander V: Prophecy* proved so expansive in scope that production of the game required an eight-figure budget- more than half of the \$27 million figure allocated to Roberts for making the feature film.

Roberts began development on the feature while still working for Electronic Arts. The film's deliberate retro look- featuring spacecraft that bore a strong resemblance to aircraft, battleships and submarines- arose from the director's desire to do a World War II movie in space. "I wanted to see spaceships going toe-to-toe, slugging it out and blowing up," Roberts remarked. "I hadn't seen any movie pull out all the stops and deliver that kind of action since *Return of the Jedi*. Fortunately, production designer Peter Lamont got on board with this approach right away, showing up with ten huge illustrated volumes containing blueprints and detail of various warships."

In addition to pulling double duty as co-writer and director, Roberts employed his own newly formed company, Digital Anvil, to handle the 290-shot digital effects load. Time-Slice Films joined forces with Cinesite London to create a fresh spin on the 'frozen-time' look popularized in recent commercials. Animated Extras was hired to provide animatronic and prosthetic creature work, while Digiscope wrangled an array of 2-D effects. Pacific Title/Mirage Studio was called upon to render the film's opening sequence.

Before the notion of handling the majority of effects in-house took hold, a number of effects vendors, including Boss Film Studios, were invited to bid the show by the film's producer, Todd Moyer of No Prisoners. Two days after Moyer received its bid, Boss went out of business. Suddenly there were a number of very talented artists faced with unemployment. Moyer snapped up Chris Brown, Thomas Dadras and Erik Strauss immediately, hiring them as the film's visual effects supervisors and effects line producer, respectively.

The initial team of ten effects artists at Digital Anvil was to double during production- not too sizable an increase, given the heavy effects shot load. The fledgling firm's first task was to produce a trailer for the as-yet-unshot film. Much of Wing Commander's colorful approach to outer space was worked out while creating the trailer, which also succeeded in its principal goal of generating international presales- a key to securing the picture's multi-investor financing.



Nearly three hundred digital effects shots were produced by Digital Anvil for Wing Commander- directed by Chris Roberts, creator of the popular computer game upon which the film was based.

Taking advantage of a film subsidy available in Luxembourg, the filmmakers chose to mount their main unit shoot in that country, on stage facilities owned by the Carousel Picture Company. The numerous spacecraft interior sets built there ranged from an enormous flight deck to cramped fighter cockpits, all taking form under the eyes of Peter Lamont and supervising art director Charles Lee. Stylistically, the various sets kept to the utilitarian, 'exposed-innards' look pioneered in space films such as Silent Running more than a quarter of a century ago. Visible ducting and pipes wended through the overheads and behind an array of Nokia flat-screen LCD monitors- units on which video playback supervisor Harry Jarvis displayed three hundred monitor graphics generated by the French company Cryo. Decades-old British aircraft called Electric Lightnings were purchased and modified severely to serve as the film's full-sized Rapier fighter spacecraft. In addition to the sets dominating Carousel's stages, the production also made its presence known in



The merchant ship Diligent passes through a hypermass jump point that instantly transports the craft through space for a distant rendezvous with the gargantuan capital ship Tiger Claw.



The merchant ship Diligent passes through a hypermass jump point that instantly transports the

the Hotel Intercontinental Luxembourg, where an online editing bay and CGI shop were established, as well as a T1 line that linked them to Digital Anvil's headquarters in Austin, Texas.

craft through space for a distant rendezvous with the gargantuan capital ship Tiger Claw.

Overall, the DA visual effects thrust was a fully digital effort utilizing Alias/Wavefront Maya. "I'd always wanted to do a film with all-digital effects," said Roberts, "and the space environment really lent itself to CGI, since we could show audiences things they'd never before seen. With space, there isn't the same issue that arises when doing modern-day landscapes digitally, where a certain measure of artificiality destroys the illusion." Without the resources or manpower to fully utilize traditional production pipelines, DA established a unique hierarchy for producing effects shots. While the digital effort, overall, was headed by Tom Dadras, individual artists would sometimes take on all aspects of a given shot, first modeling a ship, then animating, texturing and lighting it, an approach that led to a certain pride of ownership.

Since the Rapier fighters would be featured extensively in the film's numerous CG space battles, the Rapier mockups in Luxembourg became the focus of an extensive series of measurements to ensure accurate CG replication. An abundance of other spaceships seen in the movie existed only as computer models. Although concept artist Ron Cobb performed some spacecraft design work early on, the look for these vessels was determined principally by the art department, which drew inspiration from the stacked and layered look of vintage Japanese battleships. Under the guidance of supervisor Mark Woollard, a staff of nineteen British modelmakers built several spaceship conceptual models. Built largely from polystyrene and detailed through the time-honored method of kit-bashing, these models were never intended for the screen or even to be scanned, instead serving as stylistic jumping-off points for the DA team's digital modeling process. "The art department models stayed on our desks as reference," stated digital artist Scott Peterson. "We maintained the overall proportions and shapes, but couldn't really incorporate the details because they were a little underdeveloped - what looks good on a three-foot model won't necessarily work to represent a ship six miles long." While the concept model approach was used for several key spaceship designs- most notably the Confederation capital ship Tiger Claw, a Broadsword bomber, the merchant ship Diligent and a Kilrathi Snakeir vessel- other spaceships needed to fill out the warring space fleets were designed wholly at DA, a process that continued through to the end of postproduction.



The Rapier fighters and the aircraft-carrier-like flight deck from which they launch were designed to impart the sense of a World War II naval epic.

The Confederation space vessels reflected a utilitarian World War II sensibility that contrasted strongly with the organic, buglike Kilrathi spacecraft. The differing looks were further defined by color, with the alien craft painted in warmer hues. Although Chris Roberts was determined to keep the ship and creature concepts apart from their lower-budget gaming origins, one aspect of the designs done for a game did make its way into the movie. “The art department had hit on a tri-wing design for the Kilrathi Dralhti fighters that featured fold-up wings,” Chris Brown recalled. “These were very organic, fitting well within the design parameters, but they just didn’t work dramatically. We went back and sampled from all the wings of spacecraft used in the Wing Commander games, eventually settling on a knife-and-dagger form.”



The Rapier fighters and the aircraft-carrier-like flight deck from which they launch were designed to impart the sense of a World War II naval epic.

Extensive modeling of the ships was essential to creating credible space imagery. “Our approach was to build everything,” Peterson stated. “Rather than bump-map all of the pipes and fixtures— an approach that would never have held up, as close as we’d be getting to the ships— we actually built little radar units and all the various panel cut-ins with geometry. It’s important to include recognizable shapes and forms to which the viewer can relate. Applying that thought to the whole model resulted in a credible six-mile-long spaceship.” To further enhance the scale of the ships, the armor-plate hull surfaces required additional geometry to break up specular highlights. “We built in linear bevels to create these specular breakers. Wherever there was a ninety-degree turn on the hull geometry, we’d chop it off and make it into a linear bevel. Even the smallest forms were beveled to add that bit of depth. It’s hard to get specularities to work across any flat surface; so we’d build a slight slope, then push and pull to create irregularities in the surface.” Since some of the single-ship files ran to between sixty and seventy megabytes in size, to save on rendering times, closeup details and off-camera geometries were simply switched off once the digital camera had pulled away.

For continuity, texturing was usually handled by the modelers themselves. “We scanned in live-action plates to get real metal textures,” Peterson said, “so our bump-maps featured this grainy kind of metal coloring, and we used projection mapping to ensure a consistent look all over the ship’s hull. This coloration worked stylistically because we didn’t need some futuristic material— these were functional, utilitarian metal ships. Lighting-wise, the ships often fell into 2010 territory, with a very hot-looking sun side and a very cold side— therefore, details either blew out or went unseen. To keep the dark side from going completely black, we put in many running lights and let spill from the open landing bays illuminate these areas, adding color and depth.”

Animatics for the production’s space exteriors were rendered quickly at near-video resolution, with most shots becoming available for viewing on an Avid within two minutes. Even so, Chris Brown insisted the animatics be projected on a big screen. “A monitor can’t fully duplicate the big-screen look and feel,” related Brown. “Being able to view even the roughest of ship and

planet graphics through a half-decent video projector made a big difference in my ability to evaluate movement, appearance and composition.”

The film begins with Kilrathi vessels attacking Pegasus, an asteroid colonized by earth’s Confederation forces. With Digital Anvil cranking out a huge number of finals during the last month of post, Brown turned over the opening sequence to Pacific Title/Mirage Studio. “Pac Title also took later shots of the Tiger Claw setting down on an asteroid,” said Brown. “In both instances, they worked from ships and backgrounds DA provided.” PTM supervisor David Altenau used RenderMan to render the DA elements, a decision that led to a slight difference in look from the Maya-rendered cuts handled by Digital Anvil. “RenderMan had a really crisp look, as opposed to the soft near-glow that comes off the Maya renders. Since the Pac Title shots did not intercut directly with our stuff, the difference wasn’t anything objectionable. The system had some initial bugs, which took Alias a while to rewrite, but the look we got with the Maya renderer was worth the wait.”

With the asteroid’s defenses smashed, the aliens are able to steal a crucial piece of equipment—the NAVCOM computer— and the colony soon falls to the overwhelming firepower of the Kilrathi. Chris Roberts was intent on bringing feature-film-quality visual elements to the Wing Commander universe, and the physical appearance of the Kilrathi was no exception. “When we did the first games, the level of graphics quality available resembled what you’d see on Saturday morning cartoons,” Roberts observed. “On our later live-action games, we utilized animatronics, but that approach didn’t jibe with my idea of the Kilrathi as big cats— I wanted them to be able to move like cats. Unfortunately, when you have a man in an eight-foot-tall suit, that kind of motion is not readily achievable. Ideally, the film’s Kilrathi would have been full-blown digital creatures, but time and expense made such an approach impossible.”

Roberts instructed Nik Williams of Animated Extras to avoid viewing any Kilrathi developed for past Wing Commander games. “Chris’ original brief for us was to create feline Samurai,” said Williams. “Descended from cats, the Kilrathi had since lost their facial hair and learned to walk upright. The principal challenge with the Kilrathi suit design— which was developed by Pauline Fowler and Julian Murray, who sculpted several third-scale alien prototypes over a like-sized figure— was to disguise the human form within.” Towards that end, the Kilrathi warriors sported stylized armor with an exoskeletal shell, which served to mask the points at which a human performer’s knees and elbows bent. The costumes were constructed largely from fiberglass, with a chain-mail-like, foam-lined fabric providing flexibility in the midsection, hips and knees. Knee and ankle joints were hinged mechanically, with stilts utilized to make the performers both taller and mobile.

Two members of the Williams team, Mark Jones and Graham Riddell, played the Kilrathi admiral and captain, while fifteen additional Animated Extras crew members accompanied them to Luxembourg. The group’s duties included dressing the performers and operating animatronic functions built into the heads of the three principal Kilrathi. These allowed snarling lip movements for dialogue scenes and featured nictitating membranes that could cover the eye from either side, in addition to a standard eyelid. More rudimentary animatronic heads were used for two midground Kilrathi, with the remaining background creatures produced as straightforward static masks.

Foam latex was selected over silicone for the manufacture of Kilrathi skin appliances. "With all the stunts and explosions going on," said Williams, "it was going to be too easy to tear silicone, which can be rather difficult to repair. With all the bullet hits involved, there was a lot of on-the-spot rigging. Fortunately, we took all the molds along with us so the chest pieces could be remade after special effects supervisor Harry Wiessenhaan's crew blew holes in them. We would pack blood bags and guts inside, then cover the bullet hits with a thin layer of plaster painted to match the armor."

Aboard the flagship Concordia, Admiral Tolwyn (David Warner) is notified of the Pegasus disaster. He realizes the Kilrathi fleet can now penetrate behind Confederation lines and will soon have a clear path to earth unless a capital ship can be brought in to oppose the alien menace. The action switches to a merchant vessel outward bound from earth, the Diligent, captained by Paladin (Tcheky Karyo). Also aboard, and fresh from the academy, are Blair (Freddie Prinze, Jr.) and Marshall (Matt Lillard), en route to their first assignment- the capital ship Tiger Claw. While imagery garnered by the Hubble Space Telescope served as a jumping-off point for the more distant and colorful environments seen later in the film, matte paintings of earth, Venus and Mercury drew on reference materials obtained from NASA's website. However, those images wound up being enhanced rather extensively. "There were only six or seven shots of earth at the beginning and end of the film," Chris Brown said, "which was fortunate because creating credible views of earth is tough- the real thing looks like bad matte work. The NASA channel can manage because everyone knows that their stuff is real, but that same kind of imagery won't play in a feature."

Diligent receives a message from Tolwyn that must be delivered to Tiger Claw. Blair, partially descended from genetically engineered forebears, has inherited an extrasensory perception of space-time. Paladin puts the young officer's innate talent to good use, allowing him to co-pilot the Diligent through jump point Scylla- a stellar hypermass that bridges different sectors of space almost instantaneously. "When we were figuring out the rules for this space environment," Brown related, "it was decided that pulsars- rotating neutron stars, the stuff of collapsed suns- would be used for the entry and exit points we'd see our spaceships make their hyperspace jumps through."

Generating appropriate imagery for the stellar phenomena proved to be a time-consuming process. "Maya was still a beta version at that point," said digital artist Pauline Saab, "so we were lacking tools and didn't have proprietary software- there weren't any programmers to help us write stuff for particle effects. We combined Maya with older Alias product to achieve the pulsars and nebula seen in the film." The DA particle work was blended with transparent image planes and geometry-deforming animated texture maps, and then combined with the ship elements using Wavefront Composer. While entering and exiting jump points, the CG spaceships required interactive lighting to tie them into their environments. To accomplish this, a blurred image of the jump point was projected onto the ship to provide the proper colors and textures.

Three separate hyperspace jumps are shown in the film. The Diligent jump was handled primarily through exterior views of the streaking ship, while a later shot of Blair executing a jump in his Rapier fighter combined a zoom-in/dolly-out closeup with Innerspace-like light ray

animation emanating from his face. A third jump, seen from inside the Tiger Claw bridge, utilized Time-Slice, a variant on the 'frozen-time' effect that has been popularized in a number of television commercials. Tim MacMillan, owner of Time-Slice Films, had recently completed work on the NBC miniseries Merlin in Europe, and Chris Brown met with him to view a demo reel.

In the past, frozen-time had been achieved via two different methods. One required mounting between one hundred and three hundred cameras in an arc around the subject, then laboriously registering each still image produced to the one following it. The other approach used fewer cameras, with morphing software creating in-between frames, but this process introduced distortions and often produced a diffuse and underdetailed look.

MacMillan's rig obviated the need for dozens of cameras and morphing. The unit was a curving arc of machined aluminum onto which were mounted 120 Zeiss lenses, facing inward. Film was threaded behind the array of lenses and along the length of the aluminum structure, which had a camera magazine at one end and a take-up reel on the other. "It was like a big box camera," Brown commented. "Tim just popped the rig's front cover to capture a whole arc of images through those Zeiss lenses simultaneously. There was some flexibility built in, as well- the cover could be opened incrementally along its length, allowing for shooting speeds between one and fifty frames per second. To capture the frozen moment on the bridge, we cut a mouth-shaped opening in the front of the set, put the rig on the end of a Phoenix crane, and then extended it right into the set. The beginning and end of the shot take place in real time, with our choreographed frozen moment occurring in mid-take." The Time-Slice footage went to Cinesite London- MacMillan's choice for all post work- where the aspect ratio was modified to conform to Wing Commander's Super 35 format.

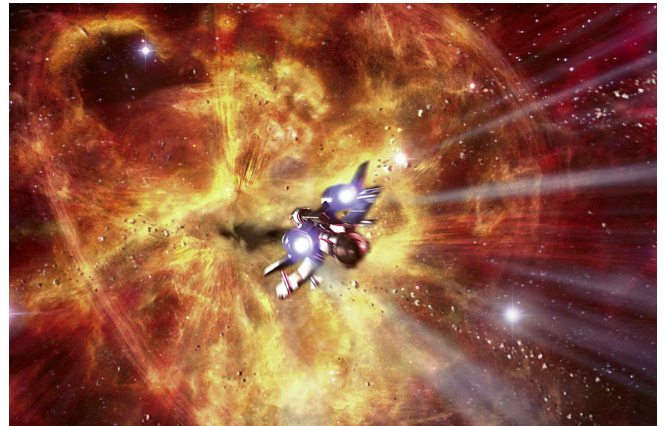
After emerging successfully from the hyper-space jump, Diligent makes her approach to Tiger Claw. "The big ships are really like central characters in this film, so the shots that introduce them required a lot of attention," stated digital artist Rhett Bennett. "Diligent comes in from the top of the screen with Tiger Claw in the distance. We follow Diligent as it goes right down the length of this enormous capital ship. Then it stops and turns toward the larger ship as big doors open up to receive it. It's about a thirty-second shot that establishes scale and shows you everything in lingering detail."

Real-world imperfections were incorporated to make shots like this lengthy approach read as both spectacular and photorealistic. "When the Diligent is on final approach to Tiger Claw, we built a deliberate operator error into the move," Chris Brown said. "The camera overshoots, continuing to track along after Diligent has stopped and begun its descent. Then the camera corrects, looking back and down at Diligent as the smaller craft enters the landing bay." The landing bay/flight deck area of the Tiger Claw was constructed full-scale, but the Luxembourg stage was too short for the flight deck to be built in its entirety. This necessitated redressing and reshooting the set to produce two different plate elements that Digiscope seamed together, doubling the length of the set.

Tiger Claw enters a star system containing a brown dwarf sun, asteroid belt and Jupiter-like planet. This colorful environment was largely the creation of digital artist Mark Goldsworthy,

who had also developed jump point Scylla. “Mark did a tremendous amount of R&D for us,” digital artist Rodney Brunet related, “plus more than seventy animatics. His brown dwarf star started out as a background painting for the original presentation trailer, but Chris Roberts loved it so much that a good deal of the film’s action wound up being centered around it.”

While on patrol in their Rapiers, Blair and his Wing Commander, Deveraux (Saffron Burrows), encounter a Kilrathi communication ship near the brown dwarf. After an aerial dogfight, the pair destroys two of the Dralhti fighters. Chris Brown directed second unit for the show. “I took a CYA approach to the Rapier fighter cockpit stuff,” said Brown, “shooting everything three different ways. We utilized a half-cockpit for tight closeups, while medium shots were done from outside the Rapier mockup, looking in at the pilots through the cockpit glass, with a translight mounted behind for the background.” Five generic nebulae were generated at Digital Anvil, then passed to the production art department, which produced the translights. A mesh screen was placed between the Rapier and the translight, softening the background and suggesting greater depth. These translights were also utilized for scenes on the bridges of Diligent and Tiger Claw, for angles that included only a sliver of window in frame. “The translights saved us from an unmanageable number of greenscreen shots- I know I’ll be using them again and again on future shows.” For the third angle, the camera was moved back further from the mockup, which was mounted on a gimbal built for the taxi scene in *The Fifth Element* and shot against greenscreen.



Ablaze with interactive illumination, a Rapier approaches the jump point, created with particle systems and animated texture maps.



Earth forces square off against Kilrathi invaders in a number of large-scale battles sweetened with pyrotechnic explosions and digital shockwaves.

The bold, hand-held look of the live-action was carried through to the digital space exteriors. “Top Gun had some terrific aerial dynamics, which served as inspiration,” said Brown. “We decided to let the smaller ships blow right into camera while adding camera shake, as if a shockwave of air has buffeted the camera operator. Of course, there’s no air in space; but the visceral nature of this approach served the story best. Adding heat-ripple when a ship’s engine passed close by was another thing we lifted from that film.”



Earth forces square off against Kiltrathi invaders in a number of large-scale battles sweetened with pyrotechnic explosions and digital shockwaves.

Another deliberate nod to the past took place whenever the Rapiers launched from the flight deck into space. “As they clear the deck, the fighters drop, making a little dip before flying off,” noted digital artist John Ford. “This was reminiscent of the motion made by a plane after it’s catapulted off the deck of an aircraft carrier. Then there’s the clamshell maneuver Tiger Claw performs as these huge hinged sections of the ship fold over the runway flight decks– it’s the deep-space equivalent to battening down the hatches and securing for battle.” Rapiers returning from combat missions to either touch down safely or crash into the flight deck were wholly the province of Digital Anvil. “There wasn’t any money to throw one of the full-size ships down the set or blow it up. So we did the landings and crashes with CG ships, adding them to the live-action flight deck.”

Seeking inspiration for the movement of the juggernaut capital ships, Digital Anvil viewed documentary footage and studied the war films *Tora! Tora! Tora!* and *Midway*. “After viewing these films,” Brown stated, “Chris Roberts was adamant about holding on shots of these big ships coming across screen for a long time. That was more daring an approach than I was at first comfortable with, but in the end these long-duration shots worked very well, and they went a long way toward establishing the necessary sense of spectacle.”

This sense of spectacle– in the best *Victory at Sea* tradition– is particularly well illustrated partway through the film, when Tiger Claw is led into a trap and badly damaged during the ensuing battle. This sequence, along with the action in the movie’s climactic scenes, featured vessels firing broadsides into one another, thus requiring extensive pyrotechnics to capture the grandeur of mighty ships in combat. Initially the idea had been to shy away from this scientifically inaccurate approach, since in reality, flames and fireballs would not long exist in the vacuum of space. “Pyro has been used extensively in space films, even prior to *Star Wars*,” Chris Brown remarked. “So a lot of R&D went into developing an alternate look. But none of it worked for our traditional, World War II kind of story. Our R&D didn’t go entirely to waste, however, since the digital shockwave accompanying the pyrotechnic blasts only came about because of it. The idea was to do something in the vein of *Star Trek VI*’s exploding planet shockwave, but then supplement it with rippling effects that enhanced the scale.” Brown budgeted a pyro shoot into the schedule, but upon returning from Luxembourg, he discovered that the Digital Anvil team had created a viable and much less costly alternative. “They’d been experimenting with Pyromania’s package of explosions on CD-ROM, and their tests were

looking great. Rodney Brunet had tailored a number of the shots to make these generic explosions work for us in the context of our scenes.”

Brunet began with a reference explosion from the Artbeats digital film library, then proceeded to add both geometry and particle effects. “The explosion would begin on an image plane within the ship’s geometry,” Brunet said. “That kept it from looking like a 2-D comp with the blast pasted over the ship. Then I did a lot of filling-in with particles that gave the blast some density.” Another aspect to the space battle was the energy shield surrounding the ships. “The shields are initially transparent, but as they’re pummeled, they grow weaker and become increasingly more visible. Eventually they are worn down to the point that missile strikes can pass right through them and impact the hull.” To distinguish between the two warring fleets, the color of pyrotechnic hits was varied, with Kilrathi vessel hits reflecting the aliens’ green atmosphere, while exploding Confederation ships registered the more traditional blue and yellow fireballs.

Creating the appearance of physical damage to the capital ships required additional modeling. “Rather than use texture deformation, we chose to break part of the digital model, then build an interior piece that could fly out in response to the ship taking a missile hit,” commented Scott Peterson. “To build in this specific kind of battle damage, we were mostly pushing isoperms around. Isoperms are to NURBS models what quads are to polygonal models, a kind of construction history- once a given shape is built, the isoperms can be picked off the model and moved to form curves or other complex shapes elsewhere.”

Blair joins a raiding party that storms the Kilrathi communication ship. In a pitched battle between man and Kilrathi, Confederation forces prove victorious, recovering the stolen NAVCOM and uncovering the Kilrathi fleet’s plan of attack. Blair next takes his fighter through a jump point to warn Admiral Tolwyn’s armada. “It became clear to us that the Confederation armada wasn’t big enough,” said Peterson, “so a cruiser-class vessel was added to beef things up. Since there wasn’t time to sketch out ideas, the ship really took shape on the monitor as opposed to being worked out in advance. We immediately opened Maya and started building. Maya’s ability to reference the models was really nice- a ship that was only fifty or sixty percent complete could still be plugged into the animatic for lighting and effects tests. Then, as the ship developed further, whenever we loaded the model for another test, Maya would automatically update to show the current level of development. This allowed the animator to work out timings and resolve move issues without having to wait for the final version of the model.”

Pursued by the Kilrathi Snakeir, Blair heads toward the Scylla jump point, maneuvering adroitly around the hypermass while the larger vessel is caught by the immense gravitational forces and destroyed. Tolwyn’s task force masses around the jump point as the Kilrathi ships emerge single-file. The Confederation ships then vanquish the invasion fleet- ending the immediate threat posed by the aliens and concluding the film.

After the effects were delivered to Fox in late 1998, many of the personnel hired for Wing Commander remained at Digital Anvil, setting to work on a new slate of gaming, feature film and commercial effects projects. Others, including supervisor Chris Brown, joined producer Todd Moyer’s startup effects facility, based at the No Prisoners offices in Santa Monica. There,

preproduction would soon commence on a feature based on the Battlestar Galactica television series.

For Chris Roberts, Wing Commander succeeded not only in transposing his gaming vision of space combat to film, but also proved to be a learning experience. "If I knew then what I know now..." Roberts reflected. "Well, I'd probably have been a bit less ambitious. I now know the kind of time and effort necessary to make a film of this scope. The picture would have looked slicker with more time and money, but I'm proud to have brought it in at this price, and proud of the finished product." With a fresh proliferation of space sagas on bookstands, and new interactive space battle games being developed as successful, ongoing series, the space war film will have ample source material to draw upon for some time to come.

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LOST IN THE BRIAR PATCH

image

ARTICLE BY Kevin H. Martin

A quarter of a century ago, Star Trek scribe David Gerrold, in a critical analysis of the original Trek episodes, observed that many long-running television series experience a hardening of the creative arteries. Rather than utilize new and different ideas to serve as jumping-off points for drama, most episodic series instead lock themselves into a set means for dealing with crisis- allowing their formats to settle into tired formulas. Star Trek was certainly no exception. One of that show's most regularly regurgitated scenarios found the starship Enterprise happening upon two warring factions. Drawn into their dispute- usually via the kidnapping of a cantankerous ambassador or the death of a red-shirted crew member- the crew would ultimately force these two parties to kiss and make up before warping off toward another trouble spot to begin the process anew.

This 'Hatfields and McCoys' blood feud premise had been used on each of the four live-action Star Trek series- especially during Star Trek: The Next Generation's rocky and script-poor first two seasons, prior to the tenure of writer-producer Michael Piller. Things improved, however, with the arrival of Piller, who worked on The Next Generation through to the end of its syndicated run and co-created Deep Space Nine and Voyager before taking his leave from the Trek universe in 1996. His return to The Next Generation- this time as producer and screenwriter for the franchise's most recent feature film- brought a renewed and welcome emphasis on character.

In Star Trek: Insurrection, helmed by returning director and cast member Jonathan Frakes,



In Star Trek: Insurrection, ninth in the long-running film series, the crew of the starship Enterprise becomes embroiled in a feud over the rejuvenating properties of an isolated planet, inhabited by the meditative and peaceful Ba'ku. Enterprise officers Data (Brent Spiner) and Captain Picard (Patrick Stewart), accompanied by the Ba'ku woman Anij (Donna Murphy), come upon a mysterious spaceship submerged in a lake.



Captain Picard (Patrick Stewart) and his crew defy their Starfleet superiors in order to uphold the ideals of their beloved Federation when they find a small group of Ba'ku colonists about to be forcibly transplanted from their world so the planet's mysterious power can be harvested by malevolent alien Son'a forces. Though his script revisited more than a few concepts that had been utilized during the series, Piller avoided triteness by electing to portray the Ba'ku as sophisticates capable of teaching even 24th-century Starfleet folk about the quality of life. The late writer-

For the first time, in a Star Trek film, computer graphics replaced models as the principal means by which spaceship shots were created. Visual effects for the film were split between two companies, with Santa Barbara Studios creating space shots wholly in the digital realm and Blue Sky/VIFX handling the planet-based effects through both digital and traditional means. The film's computer generated Enterprise E was based on an existing stage miniature constructed at Industrial Light & Magic for the previous feature. Viewpoint DataLabs digitized that model, then supplied the resulting database to Santa Barbara Studios.

producer Gene L. Coon had often utilized this kind of clever, thought-provoking reversal during his tenure on the original series, but with Star Trek: The Next Generation's 'more highly evolved' humans, the idea that Captain Picard and company might ever need to be taught a lesson rarely, if ever, arose- and when it did, the impact was dampened by rewrites and edits.

To reinfuse Star Trek with a megadose of its own 'to-seek-out-new-life-and-new-civilizations/to-boldly-go-where-no-one-has-gone-before' credo, the never-before-seen humanoid aliens portrayed in the film were located in an unexplored and dangerous region of space. Depicting this visually dynamic and colorful vista led producer Rick Berman and co-producer Peter Lauritson to explore the strange Ba'ku world and its surroundings via computer graphic imagery, boldly going further with this process than any earlier Enterprise feature voyage. While previous Star Trek films had often been the beneficiaries of new digital technologies developed for other productions, only on The Wrath of Khan had a feature pioneered computer graphics innovation. That film's 'Genesis Effect' employed fractal geometry and early computer paint systems to create a breathtaking minute-plus flyby depicting a world transforming from lifeless moon to earthlike planetary body. Since that time, The Voyage Home utilized cyberscanning, while The Undiscovered Country exploited morphing and bobbies. In addition, digital starships had been built for the last two features- Generations and First Contact- and successfully intercut with stage miniatures. But Insurrection would completely abandon the time-tested motion control model approach. Even with those past digital successes, it was a major step for the Trek universe.

The bulk of Insurrection's nearly all-digital visual effects load was divided between Blue Sky/VIFX and Santa Barbara Studios, with the former handling scenes set on the Ba'ku planet and inside a cavernous spacecraft while the latter tackled exterior space scenes. O'Connor FX provided a multitude of miniature pyrotechnic blasts, while The Chandler Group and Image G supplied motion control services. Trek veterans Michael Westmore and Terry Frazee supervised makeup and floor effects, respectively, while POP Film contributed a variety of animated embellishments to live-action scenes. Then, at the tail-end of postproduction, the film's revised finale required a combined effort between Hunter/Gratzner Industries and Innovation Arts for an exterior practical model sequence, with miniature interiors provided and destroyed by Stirber Visual Network.

Though the notion of a primarily digital Trek proved groundbreaking for the feature film series, the two surviving Star Trek television incarnations had already come to embrace CGI- as a means of portraying enormous space battles on Deep Space Nine, and for nearly all of Voyager's effects. "Paramount had an established methodology in place for tackling the effects," observed Blue Sky|VIFX president Richard Hollander. "Their group is now pretty experienced with effects- not just on the TV series, but with the last two movies done at ILM. Since it is their franchise, our effects in the film had to hew pretty closely to what had been established." While BS|VIFX was new to this universe, Santa Barbara Studios was not. Having contributed a variety of CG space environments to the last three TV series, as well as Generations, SBS had become well-acquainted with the stylistic nuances preferred by Berman and Lauritson, and as a result did not have to go through any proof-of-concept testing before being awarded Insurrection's space sequences.

SBS' first consideration was the Enterprise herself. To digitize the ten-foot ship miniature- built by ILM for the last film- SBS turned to Viewpoint DataLabs, with whom they had earlier collaborated on the floating champagne bottle that opened Generations. "Jayme Olsen handled the actual digitizing of the starship miniature," said Viewpoint vice president of production Walter Noot. "That was an enormous job in itself, but then there was the issue of reconciling the digitized data with blueprints provided by Paramount. We were terrified that Trekkies would spot the slightest variance between our ship and the stage miniature seen in the previous film. If there was a bit of droopiness in the physical model, we had to forego cleaning it up and instead make sure our CG model reflected that. Plus the ship was a compound-curve nightmare- all bevels and edges had to remain nicely rounded, no matter how close the camera got to the ship. An insane level of accuracy was involved."



The film begins with Data disrupting a clandestine surveillance of the Ba'ku, being conducted jointly by Starfleet and the Son'a, a belligerent alien race. Revealed on a viewscreen within the cloaked 'duck-blind' outpost, Federation security officers- wearing special suits that render them invisible to the local inhabitants- pursue Data through the streets of the village.

Senior digital sculptor Jason Turner served as project lead for the eight-man team responsible for the Enterprise, using a number of software packages that combined with in-house tools to aid in producing a single NURBS model of the starship. “With a NURBS model you can dial in any desired resolution level because it is mathematical, not polygonal,” Noot related. “It simplified everything because we didn’t need to build two or three separate models, each with its own resolution level. And it was smooth- no faceting. The challenge with this approach was to keep the model light, because it’s easy to do incredible-looking stuff that winds up killing you in the memory department. We utilized trims and blends to keep the model weight down while still retaining accuracy.”

With the Enterprise NURBS model completed, work began in earnest at SBS. “Doing the ships in CG allows for total freedom and creativity in lighting, motion and interaction,” company president and effects supervisor John Grower explained, “but getting them to look really genuine took a whole extra step. We shot countless textures off the ILM miniature for the CG model, then assigned a dedicated team to the ship- an approach we tried to use for other ships in the show when possible.” To provide detail that would hold up even just a few feet from the vessel, four recruits to the art department spent months painting high-resolution texture maps for the Enterprise alone.

CG supervisor Ron Moreland handled the construction, rendering and texturing of the starship. “Developing RenderMan shaders for the metallic surfaces took Ron a long time,” CG supervisor Mark Wendell recalled, “but it was a necessary step to keep the surfaces from taking on that traditional CG-plastic look. The specular highlights had to reflect the idea of a scored and patterned metallic surface, with the kind of blooming seen with a physical model shot on film.”

Two other spacecraft that were to be animated by SBS were built by Viewpoint- the never-before-utilized captain’s yacht and a new Enterprise shuttlecraft. These, as well as several other new spaceships, were designed by veteran Trek concept artist John Eaves, who found that a fully-CG universe put new demands on his talents. “The CGI guys needed every possible line drawing,” remarked Eaves. “They wanted all the details in advance- which differed from the way I usually work with traditional modelmakers, leaving areas open for them to contribute. But Santa Barbara did not want to have to go through an approval process on every aspect of these ships- which made sense, because there simply wasn’t time to make that happen while still getting the ships modeled and animated and rendered out. It was a learning experience for me to provide these detailed technical drawings.”



Data flings his pursuers into the air prior to fully doffing his own suit of invisibility. Crane-suspended stunt performers were flown on wires for the sequence. The classically styled Ba’ku village set, built at Lake Sherwood by production designer Herman Zimmerman, was the largest ever constructed for a Star Trek film. CAD techniques were utilized to efficiently cut foam for the decorative structural elements.

The captain's yacht- an executive shuttle moored to the exterior undersection of the Enterprise- incorporated existing aspects of the starship's geometry, and actually resembled a nautical craft. Named Calypso, at the request of Patrick Stewart and in honor of Jacques Cousteau, the yacht's boat shape was deliberate. "I designed the engine nacelles to fold up into the starship's hull for storage- like the wings on a jet aboard a carrier- then deploy down as the yacht undocks," noted Eaves. "Fortunately, the detail already present on the starship worked perfectly for accommodating these nacelles." Originally featured in a number of shots on the planet's surface, the yacht wound up making only a token appearance in the film.

The shuttlecraft, however, fared somewhat better. A streamlined extension of some earlier shipborne utility vessels, the new shuttlecraft featured a sleeker form and hull plating that reflected the aesthetic seen in the exterior of the Enterprise E, which Eaves had designed for First Contact. For these and other Starfleet vessels, Eaves attempted to maintain continuity. "I repeated certain shapes throughout the Federation designs," explained Eaves, "so the ships all seemed to extend from a single technological base. The scout ship flown by Data is a good example, as it used the cowled enclosed engine nacelles seen on Deep Space Nine's starship, the Defiant. That look suggested heavy shielding, which went well with its streamlined, high-performance fighter appearance." Another conceptual element- specific to the storyline- served the need for the scout ship and shuttlecraft to perform a hard dock while maneuvering within a planet's atmosphere. "Since it wasn't decided whether they'd dock on top or the bottom, I placed hatches and magnetic latches on both sections. Knowing that all of these articulations would be handled with CGI allowed me to be very particular about how the mechanisms worked. If we had used miniatures, there'd have been limits to these actions based on what could be machined within the limited physical space available in each model."

While Eaves developed the spaceships, graphic artist Geoffrey Mandel created the logos and lettering for each vessel. Peter Lauritson had intended that the new ship designs be accomplished in just six weeks, but a full six months would pass before all of the craft renderings received final approvals. The load on the art department, balancing two television series in addition to the feature, became so great that Ray Harvie was brought in to produce effects storyboards, while Edwin Natividad- fresh from Star Wars: The Phantom Menace- hired on to design a bevy of new props. "Production designer Herman Zimmerman- who was in at the beginning of The Next Generation and has done the last five Star Trek features- is really brilliant in how he selects people for the art department to expand the vision," Eaves observed. "When Deep Space Nine got started, artist Ricardo Delgado was an outsider who brought a unique perspective to the Cardassian space station- and his contributions were great. Ed served that same function on this show, and I became a huge fan of his work. He'd whip out the characters in his prop drawings incredibly fast- there was a little black ink, with the rest in marker shades- and yet the results were so lifelike. Seeing his willingness to spend whatever time was needed to make concepts work- especially on this constricted schedule- changed the way I approach concept art. He did the alien stuff- Son'a guns and bazooka, personal viewscreens, wrist computers, control pads- plus he helped Herman finalize an aesthetically acceptable and workable layout for the Ba'ku village."

The vain, cosmetically challenged Son'a aliens were but one of several new races introduced in the film— although, as principal villains of the piece, these humanoids required the greatest makeup effort. “While the Son'a are human in appearance, they're beings who've been through a dozen facelifts,” Michael Westmore elaborated. “Their skin has been pulled and pulled and pulled— it's their way of maintaining a sense of youth. It doesn't work because skin eventually loses all of its elasticity, dries out and cracks open— there are no pores left.” Westmore reviewed videos of countless movies featuring stretched-face effects, ranging from Brazil to Hellraiser. “They were all either principally comedic or gory, while this look had to fall somewhere in-between. It had to be functional without being too offensive, but couldn't ever be laughable. The other problem was time— like the series work, we never have much time on these features.” Westmore made up ten heads and gave them to different sculptors, providing each artist with the basic premise. “All came back looking very different. I laid them out in Rick Berman's office and we went right down the line, picking out elements that would work well and discarding the parts where the pull wasn't right or looked too thick. I had Jim Rowland and Scott Wheeler work on the designs, then go straight into sculpting and painting.”

The principal Son'a characters, led by Ru'afo (F. Murray Abraham), all had faces made from several overlapping pieces— including a forehead, upper eye, lower eye, upper nose, mouth, chin and separate lips— and these were adhered at the center of the face before being pulled and glued down. Even beneath the makeup, there was considerable tension on the eyes and mouth. “Whenever F. Murray stretched his face,” Westmore remarked, “the makeup moved with it like a rubber band— a one-to-one reaction, rather than the typical makeup situation when an actor has to really exaggerate his expressions to ensure they read. And the response to this look was extraordinary. We were on location with two hundred Ba'ku extras when he came for the makeup test, so all these people were standing around with their mouths hanging open when he came out into the light.” Contact lenses provided a fuzzed look around the iris to suggest the advanced age of each Son'a.

Though Roman numerals had been eliminated from the Star Trek film titles with the onset of the first Star Trek: The Next Generation feature, this film was still unofficially regarded as Star Trek IX— a dreaded ‘odd-numbered’ project. Traditionally, even-numbered Trek films have generated higher revenues, received more respectful critical notices, and in general have been better received by the public. This ‘curse’ had at first been a joke amongst Trekkies, but the ‘odd film out’ scenario gained credibility with the passage of time, to the extent that many thought this ninth Enterprise voyage jinxed. Even the picture's title seemed a trouble spot. Wags bandied about monikers like Star Trek 9000 and The Undiscovered Title, with the Insurrection subtitle not announced until near the end of shooting. To help dispel the jinx, Paramount elected to create a spectacular early teaser trailer that was deliberately designed to evoke the sort of buzz an early Independence Day promo had created a half-year prior to that blockbuster's release. The plan even involved employing Joseph Viskocil, ID4's miniature pyro whiz. But instead of the White House, the object selected for Viskocil to obliterate was one that had come to symbolize Starfleet and, indeed, Star Trek itself— the asymmetric arrowhead logo that adorned every uniform and ship of the Federation.

Paramount supplied data on the arrowhead's dimensions to Digital Muse- a company that, in its past incarnation as Amblin Imaging, had worked on the Voyager title sequence as well as trailers for Generations and First Contact. More recently, the firm had supplied extensive CGI space battle effects for Deep Space Nine. For the Insurrection trailer, in addition to creating and animating a CG Enterprise in LightWave, Digital Muse performed 3-D work on the arrowhead logo, then sent those files on to Stargate Films, where separate five-foot models were constructed from resins and other fragmentable materials.

Stargate Films president Sam Nicholson had started his career designing elaborate on-set lighting effects for the engine room and V'ger in Star Trek - The Motion Picture nearly two decades earlier; but destroying the Starfleet arrowhead proved to be an equally challenging proposition. "The most difficult aspects in dealing with the arrowhead were its physical depth and asymmetrical shape," said Nicholson. "Paramount wanted this blast modeled after the Death Star explosion in Star Wars, with a 'titanium-and-blue-sparkling-bits' mixture that would leave no debris bigger than a matchstick. Joe Viskocil came in to give us a wonderful designer explosion. But while it is easy to explode a sphere, this oddly-shaped cast object, possessing a variety of different stress points, was not so simple to blow apart. We suspended it from a crane after Joe had laced it with enough primer cord to take a car apart, but the explosion only severed the lines holding the arrowhead and blasted the whole thing- still intact- right down onto the lens. It was one of the least desirable first takes I have ever seen." The Stargate crew employed a slush mold to manufacture additional arrowheads, building outer shells filled with tree bark- principally ground-up redwood chips to create an organic look. Shot at 360 frames per second, the three follow-up takes were subsequently mixed together



En route to the Ba'ku world, a Son'a flagship emerges from the folds of the Briar Patch nebula- a treacherous expanse created digitally at Santa Barbara Studios.



Son'a leader Ru'afo (F. Murray Abraham) confers with his second-in-command aboard the flagship. Trek veteran Michael Westmore supervised makeup effects for the film.

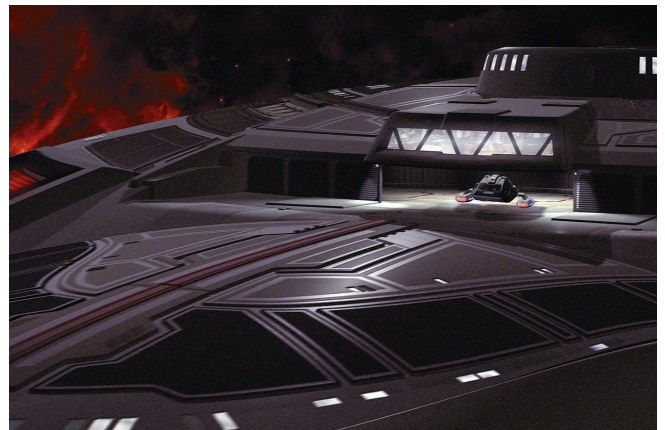


digitally to create the perfect explosion. “The whole piece started with the idea that it would be about seventy percent digital and thirty percent practical, but the pyro turned out so great that the shot wound up about eighty percent practical.” Ironically, the teaser trailer- intended to be a big ‘wow’ for summer moviegoing audiences- was tinkered with incessantly by the studio and went unseen until fall.

The movie commences on a verdant, earthlike planet, seemingly populated only by the Ba’ku, a race of humanoids living in pastoral simplicity. This illusion is soon dispelled, as Starfleet officers, working with the Son’a, a newly-allied alien race, are seen monitoring the Ba’ku from within a ‘duck-blind’- a high-tech surveillance center hidden from the locals by holographic camouflage projections- set amid rocks overlooking the Ba’ku village. Herman Zimmerman’s village set reflected architectural influences from a number of Pacific Rim cultures, and was the largest construct ever built for a Trek film, spanning nearly a mile, with practical irrigation systems for the rustic farm areas. Requiring ten weeks of construction on location in the Lake Sherwood region of Thousand Oaks, California, the village’s structural components were designed and cut from foam using CAD-CAM processes.

For the duck-blind, Zimmerman extrapolated from existing monitor perches used by anthropologists in the study of primitives. Though there was early talk of building it on stage and comping film elements of it into plates of the actual rock formation, production decided that erecting the set on location was more advantageous, as it afforded Frakes the opportunity to shoot through windows down into the village, as well as achieving reverse angles. But a complication soon arose with respect to the set’s limited interior space. “The motion control unit had to fit inside the duck-blind,” said BS|VFX effects producer John Kilkenny, “and that was a difficult

Their craft the Son’a set effect was a very rough, but by applying the VFX the perfect balance of effects to the set and the camera. The film had a lot of plates of the actual set, but the effect of the motion control unit was a fast life there. As the camera moved, the set was a side story in the plot of the movie. The veins- a look suggested to Westmore when he witnessed actual facelift surgery.



Intent upon rescuing Data- who, presumed to be malfunctioning, has been targeted for termination- Picard and Worf board a shuttlecraft and head for the Ba’ku planet’s surface. High-resolution maps of the Enterprise were painted for closeup views of the ship, while 3-D geometry created requisite hull details.



The shuttle is intercepted by a scoutship piloted by Data. Picard fires a diversionary tachyon burst which is easily absorbed by the scout’s deflector shields. Illustrator John Eaves designed the scoutship- a new vessel in the Star Trek inventory- utilizing design elements from Deep Space Nine’s starship Defiant. For later shots of the craft entering the Bak’u planet’s atmosphere,

accommodation. First, the back of the interior had to be removed so we could put the track in. Then the crew had to restore that section of set for

real flame elements were embellished with particle animation and backlit streams of nitrogen.

filming. At this point, there were all sorts of juggling acts going on, as El Niño had screwed us up. Herman was struggling to stay a step ahead of production, so the painting took place just prior to shooting. Then the rains came and seeped into the set, making it all run. That meant re-juggling the motion control shoot plus the regular shooting schedule.”

Fortunately, the majority of the main unit’s crew was well-acquainted with the demands of motion control and other effects work, many of them having labored on one or more Trek series or features. “These folks have worked together for years,” Kilkenny remarked. “The shooting schedule was really tight, so we had to be three steps ahead all the time, always making sure that the crew had our boards well in advance. We took care of that end; and when we’d show up, those grips would have already put the greenscreen up and set a generator in place for the motion control.”

Attention to detail in preparation also paid off through the generation of elements well in advance of the heavily condensed post effort yet to come. This was aptly demonstrated with the portion of the location shoot that took place in the High Sierras, nearly two miles above sea level. “We always knew that the snow up there was not going to last all the way to the end of shooting in July,” noted Kilkenny, “so visual effects supervisor Jim Rygiel went out with unit still photographer Elliott Marks during preproduction and shot a number of snowcapped mountainscapes. Having those images gave us backgrounds that we could scan in and paint to blend with first unit footage of the Ba’ku village shot at Lake Sherwood. We also took a lot of reference film while the main unit was out there, keeping a notebook that indicated what lights and gels were used, where they were positioned and the wattage of the bulbs. The artists here later received all of these tech sheets in addition to the usual counts from editorial.”

The watchers in the blind observe some of their own officers– clad in invisibility suits, but revealed on a monitor set into the observation windows– moving among the unwitting Ba’ku. “Instead of using traditional Starfleet-style graphics on that duck-blind viewscreen,” recalled digital effects supervisor Max Ivins, “a much simpler style was chosen– very nondescript, for a look that wouldn’t interfere with visual storytelling by raising any extraneous issues. The viewscreen features little in the way of detail beyond a slight optical distortion.”

Into this tranquil, yet disturbing scene storms the android Starfleet officer Data (Brent Spiner). Chased by similarly cloak-suited Son’a, Data turns upon his aggressors, initially stunning them with his hand phaser, then shucking his own invisibility suit and turning a weapon on the blind, destroying its camouflage system with precision fire that renders it visible. Considerable rotoscope work was required for the unmasking of the previously invisible figures, with Spiner peeling out of a green bodysuit on-camera. To develop a suitable look for the phaser beams fired in this and other scenes, an editor went through every episode of the series to assemble a video reference tape of phaser beam animation for the BS|VIFX staff. “Most of these shows are done shipboard or in dark spaces,” Ivins remarked, “so this was a new situation. Logically, when a phaser is fired against a light sky, it should pretty much disappear. There was a lot of thought and no small amount of cheating going on to bring the element up while keeping the luminosity

of a phaser and not giving the impression it's been pasted over the bright background. That's where all the reference material came in handy. 'See this one? Don't make it look like that.'"

For Data's destruction of the holographic projection shrouding the blind, Ivins first painted in a rock to cover the set piece. "The problem was showing that rock image being eaten away after Data has shot out the holo-emitters," Ivins related. "There were little undulating blast points that spread across the rockface to expose the duck-blind structure. We first tried a 3-D approach that took the effect round to the back side of the blind, then a 2-D approach, before finalizing a hybrid of the two that employed separate layers of animated hits to suggest depth." The Ba'ku people, initially shocked by Data's appearance, react even more strongly as they stare up at the humans and Son'a revealed within the now-exposed blind.

The action switches to the starship Enterprise, where Captain Picard and his officers host a full-dress-uniform reception for a group of diminutive aliens whose world has just become a protectorate of the United Federation of Planets. Separate head and face pieces for each of the amphibian-like beings were devised by Michael Westmore and his team. Receiving word that Data has run amuck, Picard orders the ship to the Ba'ku planet. The Enterprise E speeds away in a shot that showcased SBS's decidedly nonstandard approach to mapping the CG starship. "We went for a fairly complicated method of texture-mapping the ships using projection lights," explained John Grower. "A whole cloud of these lights is positioned around the model in space, aiming inward. Each light projects a single texture, so we are not just mapping a side view, a top view and a front view- we're projecting textures that cover all the nooks and crannies in the model."

While not brand-new, the technique of texture-mapping a model surface with the use of projection lights had not been attempted at SBS previously. "The projection-mapping technique is somewhat counter-intuitive," Grower conceded, "but in CG, compound-curve-intensive shapes- which nearly all of these vessels, with the exception of the holoship, happen to feature- are difficult to project textures onto in an orthographic manner, due to the stretching that takes place along the curves. Our projection technique can handle these complex curved shapes without any need to break up the geometry- you can just start projecting. It was also good for preventing stretching at the poles on our CG planet. The problem with this approach stems from the points at which various projections overlap. Blending those together- seamlessly and invisibly- required us to develop quite a bag of tricks. But it's definitely the approach when dealing with this type of complex shape. Each of the images can be extremely high-resolution, so we were working with 4K images a lot of the time."

Each of these projections was essentially a layer of information. A hierarchy of textures had to be established, and while this proved to be an R&D-intensive process, it was necessary in order to eliminate bizarre juxtapositions, such as one side of a ship appearing over the other. "Once projections were lined up and hierarchies properly determined, the texturing system worked remarkably well," noted animation supervisor James Straus. "We also had to build a lot from scratch while doing cheats here and there. A tremendous amount of extra detail was needed for that first reveal of the Enterprise, and even more resolution for a close view of the shuttle bay. But once we had the system set up, all it meant was putting in more projection lights with special custom textures for specific cuts."

Due to time constraints, animatics for space sequences had been generated while the ship models were still being built in the computer. Though SBS committed early to using Maya for animation, that was not the only platform involved. “We started Maya as a beta test,” Grower related, “but we had many good Softimage artists and animators, so that system saw use early in the pipeline for a lot of animatic work. Then we wrote some code and used a lot of glue to go from Softimage to Maya. Our TDs were all Maya-trained; and this let us give them already-worked-out camera position data so that they could go right to work.” SBS was provided with technical assistance by Pixar in the creation of an exporter that allowed the Maya work to be outputted to RenderMan at the end of the pipeline.

Most of the initial spacecraft animatics did not incorporate a moving camera– an aesthetic that would soon change. “When the first shots went to the TDs for compositing the space environment,” Mark Wendell remarked, “everyone realized the images weren’t sufficiently compelling. By keeping the ship and camera sliding through space, the reworked imagery suddenly became much more dimensional and interesting. The reality and presence of the spaceships were also enhanced through image downgrading– sometimes they looked more real with less detail. We even considered rendering at half of film resolution, but that could have been going too far. In nature, nothing ever looks too sharp-edged– there’s a softness to reality, and we emulated that through blurring and blooming.”

During the run of the television series, spectral star streaks were glimpsed outside the windows of the Enterprise D while in warp drive. No such shots had been called for in prior features, but for scenes of the Enterprise E en route to Data’s aid, the streaks were to be seen through the windows in Picard’s quarters. The blue-and-yellow star streaks used in the series were originated on film by ILM for Star Trek: The Next Generation’s pilot episode, while in later years, streaks featuring compound moves were created by various digital effects providers. The star streaks in *Insurrection* were more straightforward, with POP rendering colorful 2-D versions. The ship’s replicators– devices capable of producing food and drink and other small items out of reconstituted matter– also fell to POP, which rendered the energy-



Among the indigenous inhabitants of the Ba’ku planet are palm pets. The computer animated creature was designed and rendered at the New York studio of the bicoastal Blue Sky|VIFX.



An alien hummingbird hovers before Picard and Anij in an ‘altered reality’ state of slowed time– a feat of raised consciousness practiced by the serene Ba’ku. The bird was computer generated at Blue Sky|VIFX, where animators referenced high-speed photography of real hummingbirds to aid them in creating the slowed flapping of wings.

curtain effect in the style of a transporter beam, but with more oomph and contrast for big-screen considerations. The single shot that featured both star streaks and the replicator effect was cut from the film during pre-release tightening, but POP's numerous viewscreen composites and Starfleet-issue transporter beam effects were retained. POP also supplied these transporter elements to BS|VIFX and SBS for compositing into their own shots.

While the Enterprise is in transit, a Son'a flagship emerges through a gap in the 'Briar Patch'— a dense, vibrantly colorful nebula that enfolds the Ba'ku world, thus isolating it from normal space— and approaches the planet. Many of the movie's spaceship sequences take place inside the Patch, which SBS art director Richard Kriegler created with dozens of digital matte paintings. During the extended bidding process that preceded production, Kriegler had executed proposal art for three other effects facilities, incorporating each house's style, before his work helped land SBS the space sequences. "Altogether I had done about 150 conceptuials," said Kriegler, "but because each house had its own take or style and my work reflected that perspective, Paramount never realized they were getting all of this stuff from the same guy. In the end, all of this really helped me narrow down and nail the look for the Patch."

The establishing shot of the Briar Patch— as seen from the outside— featured various outgassing, backlit patches meant to suggest cosmic-sized forces within, venting outward. "For conveying the power of those energies contained in the Patch, I considered that luminous aspect crucial," Kriegler stated. "I intended to utilize these areas for shots inside the Patch, too, as sources for lighting the ships. That backlit light bursting through helped with the dimensionality aspect of the Patch enormously, but it was one of the first things Paramount asked me to take out— which I did, regrettably— though eventually they relented and went with it." The numerous paintings took Kriegler anywhere from five hours to five days to finish. Rendered at 7K-by-5K, many were mapped onto 3-D geometries to create parallax shift during camera moves.

"The thicker parts of the Briar Patch were supposed to be pretty much impregnable, hence the nickname," Mark Wendell remarked. "It really slowed everything way down and allowed for the cat-and-mouse aspects of pursuit." In addition to the Kriegler paintings, Wendell utilized two other approaches for rendering the Briar Patch. "Matt Rhodes of R&D created custom volumetric shaders using Mental Ray. There were a variety of options for controlling the amount of frilly-fluffy edge detail and softening shadows and altering the density of the core. Whenever you see a really nice piece of 3-D Briar Patch go by in the foreground, it's a piece of geometry modeled in Maya as an organic, enclosed NURBS shape filled up by the volume shader. Darren Lurie was the TD working with Matt; and he did a fantastic job of mastering that shader, in the process learning to see in advance the differences between a modeled object and how it would look at the end of the process. The object's thickness— as seen along the camera's vector axis— really affected the degree of density that could be extracted using a shader. This difference was especially noticeable when you saw a shot of a hardware-rendered solid, then viewed it again after it went through the volumetric renderer. These bizarre shapes with stretched edges extending outward would become very thin, diaphanous forms when put through the volume renderer— a fiberfill kind of look."

The third approach— which, unfortunately, due to the rendering time required, saw use in only a limited number of shots— was Wendell's own, and a kind of extension of his work on the Voyager

title sequence, when the ship plows through a nebula, displacing stellar matter around it. "Paramount had always liked that look of a vessel pushing through hundreds of thousands of softly rendered particles that swirl in an interactive fashion," remarked Wendell. "I tried a lot of different renderers before settling on a custom one called Blender- a cousin to our hair renderer, with the underlying engine for each being quite similar. It was like hardware rendering in Dynamation, where for each particle a texture map is displayed. But those hardware renders don't allow for shading from light sources or motion blur. That's the nice aspect of Blender. It takes the scene you've developed in Maya and allows you to generate interactive shadows both ways, from the ship to the particles and from the particles onto the ship. Hundreds of thousands of particles take several hours per frame, but the results are nice."

The first look at Ru'afo's flagship utilized Wendell's Blender work, producing a striking effect of dewy material- Briar Patch residue- clinging to the ship as it emerges from a thick part of the Patch and heads toward the Ba'ku planet. "This was the first time the Patch was viewed from the interior looking outward," Wendell stated. "It was a great opportunity to study the Patch, so I spent a while developing the way these gases cling to the ship before they swirl off. The trouble was that you didn't really see much of the ship until halfway through the shot. This is the first time the Son'a flagship gets seen, so that took priority over showcasing the Patch. I wound up redoing the reveal so that the gas would dissipate much faster."

The John Eaves design for Ru'afo's flagship was immediately approved, though the front and back sides of the vessel were later reversed by Peter Lauritson. "Since the Son'a are highly aggressive, I built the whole thing using shapes that reflected those tendencies- principally horseshoes and boomerangs," Eaves noted. "The resulting flatness was a concern to some, so I tried tipping it up and putting it on a vertical axis- something that doesn't happen very often with ships in the Star Trek universe. But that wound up being unnecessary, since the animatics demonstrated that anytime a ship started banking, it would no longer just be a flying blade on the verge of disappearing against the background."

Two larger Son'a battleships appearing later in the film went through more in the way of design refinements, though Eaves was able to make all of the Son'a ships relate by incorporating surface detail on each that suggested a piano's interior works. "Herman Zimmerman had me doing bridge concepts for these ships at the same time I was working on the exteriors," noted Eaves, "so together we were able to come up with a rough idea of what Son'a technology looked like. Then it was just a matter of incorporating those elements into both interiors and exteriors. The set decorators and SBS took it from there." SBS artists were afforded considerable leeway with the coloration of the Son'a ships, most of which were imbued with a bronzed hue that contrasted nicely with both the Starfleet vessels and the Briar Patch backgrounds.

Ru'afo's flagship, which carries Starfleet Admiral Dougherty (Anthony Zerbe), comes under attack from a Federation scout ship piloted by Data. Both vessels were animated at SBS. "There is a kind of look and feel in the way ships move and conduct themselves in these pictures," said James Straus, "and it's usually like a naval battle, with broadsides being fired off. In this movie there was an attempt to do more wild actions- probably since we were using CG and didn't have to worry about the lack of flexibility with model mounts." Still, there were other difficulties faced by Straus in realizing multi-element space shots. "I found that when calculating camera

moves with hi-rez ships zooming away from a hi-rez planet, the numbers got so huge that the computer could not handle it. I was dumbfounded. We employed two animation software packages on this show, but neither could achieve the accuracy level needed. If everything stays small or stays big, you're okay; but when the resolution changes, the numbers just go out the window. While previsualizing, we saved on render time by using a smaller planet. For the actual shot, we would use a larger planet and position it further back in the frame just prior to rendering, which meant readjusting the lights for the planet to new positions."

Dougherty is mystified by the android's ambush, watching as Data's ship heads back to the ringed Ba'ku planet, which is positioned within a cavernous open space inside the nebula. For the rather earthlike planet, SBS created a greenish-blue globe. "We started with real earth reference," Richard Kriegler said, "then altered the land mass contours. It took seventeen matte paintings to go around this 3-D ball- we just kept spinning the planet to different positions and putting new cloud masses painted by TD Virginia Bowman over it, which hid a large part of my planet work. I wound up having to repaint the planet anyway for close shots, since this ball wasn't going to hold up once the ships started diving into the atmosphere." In the story, the blue-green striated rings around the planet contain metaphasic radiation that provides the inhabitants below with a virtual fountain of youth. The rings were also designed by Kriegler, then built in 3-D, with twinkling elements added through particle systems.

The Enterprise arrives, and Picard convinces Dougherty not to terminate Data, whose seemingly mutinous and irrational behavior suggests outside influence or a severe conflict in the android's programming. The captain and Worf (Michael Dorn) board a shuttlecraft that will take them towards the planet, hoping this ploy will bait Data into coming out after them. James Straus, known primarily for his character animation, had longed for an opportunity such as this to animate spaceships- but the task was far tougher than he had anticipated. "The number of options available made the scene complexity very high," Straus recalled. "We'd reanimate the ship, then the camera, then the ship- it went on and on and on. In going from millions of miles to just feet and inches separating the ship from the camera, our animation curves broke down and the computer freaked out. Plus all of the detail on these ships



Investigating unusual sensor readings emanating from a lake near the Bak'u village, Picard, Data and Anij uncover a cloaked Federation spacecraft- an enormous holoship being illegally used, at the instigation of the Son'a, to implement the forced relocation of the Bak'u colonists to another planet. A physical model of the holoship was produced by the Blue Sky/VIFX model shop for scanning. Contours of the ship were revealed through a combination of CG refractive elements and reflections as water streamed down its cloaked hull.



Gaining entrance to the ship, Anij and the Enterprise officers discover a near-perfect holographic recreation of the Ba'ku village within its cavernous interior. Greenscreen foreground elements of the actors were combined with plates of the actual village location.

had to hold up at very close range.” This was most clearly in evidence during the departure of Picard and Worf via shuttlecraft from the Enterprise, which featured an extremely close view of the saucer topside where one of the hangar bays was located. SBS created a tiny scene featuring digital characters glimpsed within the large windows overlooking the bay.

The scout ship flown by Data quickly intercepts the shuttlecraft, and the two vessels speed planetward. “We used real flame for the reentry heat texture map,” stated Mark Wendell, “then warped that over some cone geometry and rerendered to get the reentry heat look. We would multiplane the edges to keep from getting that crispy CG look, then cycle the textures through quickly, sometimes enhancing them with backlit nitrogen streams or particle animation work.” Approaching the planet’s surface, the two craft descend into sunrise, and soon thereafter Worf deploys a magnetic clamp that latches the shuttlecraft to Data’s scout ship. Unfortunately, the two ships remain linked together while plunging toward the ground, managing to pull out only moments before crashing. Many sky backgrounds used for the sequence came from aerial shoots– conducted by Clay Lacy in a Lear jet and Kevin LaRosa in a helicopter– though SBS wound up performing a number of color corrections in order to match the elements with the planet’s greener-than-green appearance. For more dynamic plate shots that could not be achieved with aircraft– most notably one featuring the two ships plunging down through frame as the camera twists through a sweeping arc to follow them– James Straus combined cloud elements with Richard Kriegler digital matte paintings to produce a multiplane environment in Soft-image through which the camera could travel.

But even after all of this compositing work had been completed, the CG ‘feel’ still remained in some shots. “To take it one more step,” Wendell explained, “we took advantage of Nothing Real’s Shake software, which let us comp the ships by dilating the matte to take the edge off. Shake let us play with blur and opacity factors and really marry these two craft into the background, even to the point that the TD could add grain himself.” More complex shots fell to the 2-D compositing department, where lead compositor Vincent Shaw utilized Flint to deal with rotoscoping, complex tracking and color correction issues. A number of close views on these vessels revealed Data, Picard and Worf within cockpit windows, so SBS would either track and composite live-action plates into the viewports or create digital characters. SBS supervised all on-set plate shooting, with Image G handling the motion control setup on the Paramount stages. These scenes included numerous viewscreen shots on the various starship bridges, together with a week of shooting viewport windows for the shuttlecraft, scout ship, captain’s yacht and holoship interiors.

Data is brought under control and Picard learns that the android– who had been damaged by Son’a weapons fire– was defending the Ba’ku when he went on his rampage. Meeting with people in the village, Picard is taken with their calm, nontechnological existence, and resolves to uncover the truth about the unusual alliance between the Son’a and Admiral Dougherty– a pact that seems bent on disrupting the pastoral existence of these six hundred villagers.

His damaged circuits repaired, Data begins to bond with a young village boy, Artim (Michael Welch). The boy has another companion as well– the ‘palm-pet,’ a small creature native to the planet. Blue Sky|VIFX in New York was tabbed to produce the alien digitally, working without benefit of palm-pet storyboards or concepts. “We gathered our full team of modelers, designers

and animators,” commented digital animation supervisor Mark Baldo, “then began submitting designs based on a vague script description suggesting a cross between a caterpillar and a jellyfish. We went through some amazingly cool designs, eventually tailoring it to look like a baby seal or walrus mixed with small rodent elements. Shaun Cusick sculpted both the maquette and the 3-D computer model, which was modeled in Alias and animated in Softimage. He incorporated elements of his very fat pet cat into the final rendition, and something of my baby daughter Miranda, as well, which gave the creature these huge cute cheeks.”



To escape attack from marauding Son’a shuttles, mutinous Enterprise officers evacuate the Ba’ku from their village and lead them to the safety of the mountains.



Small drones deployed by the shuttles home in on the fleeing villagers. Both the drones and the shuttles were computer generated by Blue Sky|VIFX.

The palm-pet's design phase commenced a scant two weeks before Baldo, along with team members Christopher Scollard and Mitch Kopelman, was due on location with a maquette to be used in photographing reference plates. "The first shot- which was supposed to be simple, with one kid passing it to another- wound up being staged up in a tree," Baldo remarked. "There was a moving camera with rack focus going on through this dappled-sunlight scene, so it became a monster tracking job later. We were tracking the hands of these kid actors as well as the movement of the camera, which included a tilt and a dolly-out. Jonathan Frakes gave me so much freedom it was shocking. He said, 'You're the animation director, so get up in that tree and tell the boys what you need.'" After live-action had wrapped, Paramount rethought the characteristics of the palm-pet, deciding that the creature's movements should be extremely slow. As a result, the fast-moving animation already completed had to be discarded.

Picard and Data, in the company of Artim and Anij (Donna Murphy), a Ba'ku woman, find more signs of Federation interference on the planet while exploring. Detecting a suspicious reading from a lake, Data enters the water, marching along the lake bed. A cut of the character underwater was accomplished via live-action tank photography. To hide the clearness of the tank water, BS|VIFX processed production's imagery to create a murkier environment, then designed and animated an inquisitive iridescent fish that catches the android's eye.

Emerging from the lake, Data opens dam floodgates to lower its water level. The giant pipe through which the water drains required digital alteration. "It was your typical old rusty metal pipe- the kind found in California, not in the Briar Patch," said digital effects supervisor Mark Rodahl. "So we transformed it into a Ba'ku pipe, painting it with stone textures."

With the waterline appreciably lowered, the group is able to detect a strange displacement in the water, which is soon identified as a cloaked Federation vessel. Picard, Data and Anij take a rowboat across the lake and board the still invisible craft. Upon entering, they find themselves gazing down at a perfect replica of the Ba'ku village. The Starfleet officers realize they are aboard a holoship, and that Dougherty and the Son'a must be intending to use this holographic projection to house the Ba'ku after beaming the entire sleeping populace from their homes. Once aboard ship, the people could be transplanted to another world without their knowledge or approval.



A Ba'ku is tagged by a dart fired from one of the Son'a drones, causing him to dematerialize. The dematerialization effect was originally designed to replicate the look of the well-established Federation transporter effect- realized through particle animation. Ultimately, however, Blue Sky|VIFX took an entirely new approach, creating shimmering distortion- glass imagery.

Early John Eaves designs for the holoship were scrubbed for being too traditionally Starfleet in appearance. One resembled a tug, while another, with the saucer/dish area serving as the holodeck section, featured add-in engines up top. Rick Berman wanted a blockier-looking craft, and Eaves obliged, with the resulting design constructed as a scanning model built by Mykel Denis and Tom Griep of the BS|VIFX model shop. Unfortunately, when the model went to Lauritson and Berman for approval, the producers realized they had misinterpreted the Eaves artwork, only now seeing that the ship's bridge was set at the rear of the vessel, like the conning tower of a modern-day supertanker. "This caused some concern about logistics," observed model shop supervisor Carlyle Livingston. "Keeping the bridge positioned as it was in John's sketch meant there would be an expanse of ship seen out the window every time you looked forward- which would be both tougher and pricier than just seeing the usual starfield. We moved it up front, then built a few different bridge conning towers before they signed off on it." The revised holoship was constructed by BS|VIFX 3-D digital modeler Robert Rioux. Data files for the model were then transferred to SBS, as that house would be animating it for space scenes occurring near the end of the picture.

But for initial views of the still-cloaked holoship sitting half out of the water, a stylized semi-invisible look was needed to subtly reveal the large craft's exterior contours, a task handled principally by BS|VIFX R&D supervisor David Stevens. "It was decided that the cloaked look would, in part, resemble one of those old glass ashtrays being dipped in a tub of water," Mark Rodahl stated. "Adding reflective glistenings of water dripping off the above-water section of hull helped bring out the ship's stealth-like nature, while the scale of the vessel was enhanced by adding a refractive element, as well as CG foam on the surrounding water to indicate the ship's 'footprint' in liquid- the measure of displacement its presence created in the lake."

A Son'a guard within the ship's 'village' opens fire on Picard and Data, damaging an interior wall and exposing the hologrid generating the illusion. Greenscreen footage of the actors was composited with a digital rendering of the interior, festooned with holo-emitters- which was meant to span nearly three football fields in length. "We worked up several new hologrids to provide Paramount with a choice," commented Max Ivins. "The holo-emitters couldn't look too different from previous ones, but since this holoship was the newest and best ship in the fleet, a justification could be made for allowing the look to evolve a bit. It's a 3-D element. While there was not much in the way of camera movement, there were a number of different angles, so it paid to do it as one 3-D element rather than a whole slew of 2-D paintings. If we needed to make changes, we could go in and paint them; but modeling in 3-D was necessary due to the wealth of detail."

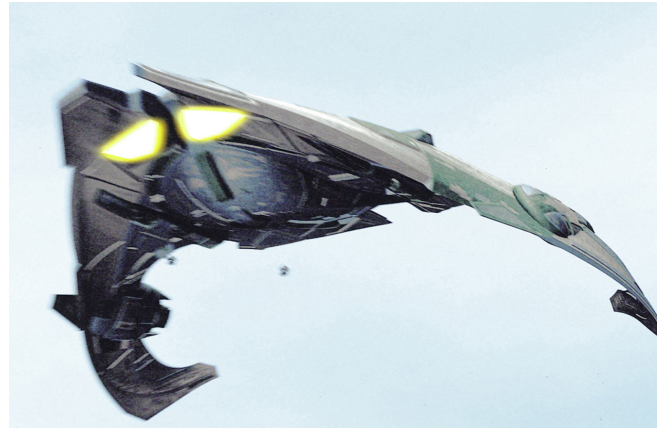
The Starfleet officers succeed in stunning the Son'a, with Picard then decloaking the holoship. "Decloaking the ship in broad daylight meant matching the caustic ripple lighting, reflections and shadows present in the plate," stated Jim Rygiel. "The holoship reveal was an image-warping look that maintained the established Federation style."

Finding his crew growing more vigorous and healthy, Picard confronts Anij, who reveals that the metaphasic radiation in the planet's rings serves to rejuvenate all of the Ba'ku- now revealed as space-going colonists who landed three hundred years ago and forswore their technological roots- and is a virtual fountain of youth. Meeting aboard ship with Dougherty, Picard is told that the Son'a/Federation plan is to remove the Ba'ku from their world, then harvest the energies in the rings, which will leave the planet uninhabitable. Ru'afo has conned the admiral into believing that the energies will be shared with billions of other beings in the galaxy who can benefit from the metaphasic effect. The Son'a have massed a battle group in orbit to ensure that these plans succeed, and Picard is ordered to leave the system. Faced with the classic Trek dilemma- do the needs of the many outweigh the needs of the few?- Picard sets in motion the 'insurrection' of the film's title.

Aboard a Son'a vessel, various cosmetic surgeries are underway in the body sculpture room. For speed, many background Son'a faces were executed as one-piece masks, but this scene featured several Son'a characters in closeup, requiring additional principal makeups. Random pulls on the multiple facial appliances for each principal Son'a produced unique and fine wrinkles that differentiated the individual characters. Ru'afo undergoes a facelift touchup on camera, and to enhance the effect,

BS|VIFX digital compositor Raphael Col—n executed a morph using Chalice to bridge between his wrinkled visage and a smoother look.

Two different types of female aliens- the Ellora and the Tarlac- are glimpsed in the body sculpture sequence, performing massages on the Son'a. "The idea was to start by hiring beautiful women with nice faces," Westmore explained, "and, rather than transform them into hideous aliens, try to retain their beauty, creating a look around their facial features." The Ellora heads came from a basic dinosaur shape, with coloration borrowed from python skin, while Yolanda Toussing's hairstyles reinforced the vertical oval lines of the forehead. For the leonine Tarlac makeups, featuring pronounced foreheads- a Next Generation standard- it was not feasible, given the time and manpower available, to create custom molds for each



Passing over the fleeing Bak'u villagers, a Son'a shuttle releases a cluster of drones designed to subvert the transporter inhibitors the Enterprise team have planted to prevent the Bak'u from being involuntarily beamed off the planet's surface.



Compositing supervisor Edwin Rivera and digital supervisor Mark Rodahl- charged with creating not only the shuttles and the drones, but the holoship as well- study a shot in progress at Blue Sky|VIFX.

performer, so Westmore designed his appliance around the most representative forehead in the group, determining that the resulting piece would stretch to accommodate both larger and smaller heads. When alien mercenaries were needed to fill out the crew on the Son'a ships, Westmore created male versions of both races.

Aboard the Enterprise, Picard hurriedly packs weapons onto the captain's yacht prior to taking the craft down to defend the Ba'ku. Confronted by his executive staff, Picard finds they concur with his mutinous decision, which they believe is in keeping with Federation ideals. Commander Riker (Jonathan Frakes) takes the Enterprise on a course that will lead out of the Briar Patch so that an advisory signal can be sent to Starfleet Command detailing the situation, while the others board the yacht with Picard. Once on the planet surface, they erect transport inhibitors to prevent forced beam-outs and form plans to evacuate the Ba'ku to the mountains, where caves containing unique mineral deposits will block Son'a transporter signals and keep the villagers safe from forced beaming.

Then Son'a shuttles emerge from the night sky to attack the village. These shuttles would evolve from an earlier concept for stand-up jet bikes. While that approach- requiring extensive character animation for the Son'a figures aboard each unit- was technically challenging, the rejection of the jet bike concept stemmed not from technical difficulties, but from the production's desire to avoid evoking any comparisons with the speeder-bikes in Return of the Jedi. With looks for the Son'a flagship and battleships established, the revised Son'a shuttle design- essentially a flying tent spike- was sculpted by Gregory Jein. "Our work on the shuttle began with an examination of Greg Jein's sculpture," Carlyle Livingston related, "and then Dave Chamberlain did a foam sculpture based on that and John Eaves' artwork. John always tells you his drawings are just a guide that you can add to or subtract from as needed- which is a very generous attitude- but we tried to stay with his design anyway, only adding some thrusters."

When blasts from the attacking shuttles demolish the Starfleet transporter inhibitors, a number of Ba'ku are caught by Son'a transporters and unwillingly beamed off the planet. Real-time motion control on location was used to capture the fleeing Ba'ku in tracking shots. "That was a major physical aspect of the show," John Kilkenny remarked. "We needed a track that could keep pace, moving as fast as the running people."

After an empty plate had been shot, the Ba'ku extras were subdivided into smaller groups and filmed in additional separate passes. "One of the groups ran by right in front of the camera," stated compositing supervisor Edwin Rivera, "while those being beamed out were another group set further back from the camera. The last grouping contained a number of Ba'ku, plus Data, who see the beam-out happen right in front of them. Unfortunately there was a tiny wobble in each plate, and that was enough to create differing harmonics that put us a couple of pixels off and made for lots of problems and inaccuracies. We had to stabilize every single pass, treating each one individually to make sure they weren't jiggling against one another." Three months of roto were required to make sure these groups of people integrated without interfering with one another. Numerous shadows also had to be added, along with an interactive beam-up light. "While the various passes were shot motion control, the people themselves couldn't be motion controlled; so with all of the belongings they were carrying and

with their hair going all over the place, it was difficult to tell where each group started and just how fast they were all running.”

Originally the capture and teleportation of the Ba’ku was to feature a digital version of the ILM transporter effect seen in earlier Trek films. “I had the people turning into vertical light streaks,” noted Max Ivins, “with residual particles that continued to drift in the direction of their original movement. I used a 3-D process based on each person’s outline and contour. But since this was not a Starfleet/Federation beam-out, Paramount decided that effect would not be appropriate.” The ‘tag-out’ – as it came to be called – instead utilized a shower-glass-style shimmer approach.

Led by Picard and Anij, the remaining Ba’ku – represented by the largest contingent of extras employed on the film series since the recreation deck scene in *Star Trek – The Motion Picture* – begin their exodus to the mountains. But the Son’a shuttles return, launching numerous flying drones that fire darts at Picard’s crew and the Ba’ku, tagging them and allowing the Son’a to beam them up in spite of the transport inhibitors. Jim Rygiel had wanted to see armies of drones nimbly swarming and being blasted, but Frakes and Berman went thumbs-down on the approach after viewing a test. “I thought we’d be able to perform some elaborate drone moves,” Rygiel admitted, “but Paramount came back at us with some theory of the Star Trek universe to explain why the drones couldn’t behave this way. The drones wound up retaining just a bit of attitude, but we lost all the barrel-rolling. Essentially they’re just brainless – barely smart enough to lurk around corners – but when they come for you, it’s like a school of sharks.”

The ensuing battles between Starfleet officers and the Son’a drones result in the destruction of several of the airborne harriers. “For the drone explosions on location we always filmed empty plates first,” related John Kilkenny. “Then Terry Frazee would put an explosive on the end of a fancy fishing pole and stand right in the shot as the bomb went off. We’d have to paint out all of the extraneous stuff after the fact – including Terry. Sometimes the drones were supposed to blow up while still way up in the sky, too far away for the fishing pole trick. To suggest those more distant explosions, we needed additional pyro that could be digitally repositioned. Frazee’s son Logan called with the exact formula used on the location pyro mix, so we hired Richie Helmer to build another half-dozen bombs, then filmed those explosions on our stage.”

The physical design for the drones underwent a last-minute change as well, with Ed Natividad’s brass-winged ‘organic’ version falling out of favor and a more mechanical-looking device needing to be designed and built on the fly. The BS|VIFX model shop was called in. “We had about two days to get the drone changed over and to the set,” Carlyle Livingston recalled. “We built two, with Erik Haraldsted fashioning a mechanism that allowed the front to dilate open when you pulled on the tail. Everyone seemed to enjoy playing with this evil flower-thing.” The articulated iris revealed the source of the drone’s tag darts, though few if any practical darts saw use in the final cut. Mark Rodahl’s crew matched its CG darts to a reference plate of the real ones, working from an image of a smashed-up drone on the ground, its darts partly visible within. Though Livingston’s shop did the pattern work as well as the molding and casting, final assembly of the breakaway drone was accomplished by the main unit prop department.



In a climactic exchange of firepower with the Enterprise, a Son'a battleship is blown to bits. O'Connor FX provided a variety of pyrotechnic elements for the sequence- including a black buck of the ill-fated ship- which were embellished with digitally painted backgrounds.



Visual effects producer John Kilkenny and effects supervisor Jim Rygiel prepare to shoot the death of Starfleet Admiral Dougherty (Anthony Zerbe) within the Son'a facelift unit. The shoot was accomplished on the Blue Sky|VIFX stage during post.

The showcase scene for the practical drone and darts were to have involved Data's inadvertently knocking three Son'a soldiers off a cliff. To save them, he grabs a drone and fires tags at the falling figures, causing them to be beamed to safety. "We had CG figures in the wide shot," noted Jim Rygiel, "while in a closer view there were stuntmen on descender rigs shot in front of a green wall. They beam out while pulling even with the camera. Our CG guys looked better than the real guys since the rigs limit a man's range of motion- the digital figures could tumble and flail a lot more." Rygiel lamented the scene's deletion from the film's final cut. "Plotwise it was never all that great- which I guess is why it went- but what we were doing with it would have turned out terrific."

In a quiet moment, Anij introduces Picard to 'altered reality'- a state in which time seems to slow down all around them as they come to exist purely in the moment that stretches. Settling on a means to realize this altered state cinematically required considerable time. "When we first talked to Paramount about 'altered reality,'" recalled BS|VFX executive producer Lee Berger, "'time-slice' came up right away, since the frozen-time commercials were airing. We have a rig for that here, but Paramount said 'no' to that approach, realizing that by the time this film appeared the effect would be old hat. Since Star Trek takes place in the future, they felt it was necessary for us to steer clear of a look that was already played out in 1998."

While various concepts for 'altered reality' were considered, one element in the sequence was locked in rather early- the hummingbird-like creature that constitutes a recurring visual motif throughout the picture, representing the beauty of the Ba'ku world. "We started on the hummingbird with the idea of developing a new creature," said Mark Baldo, "but were reined in when the first pass looked too Dr. Seuss-like. The hummingbird turned out looking like a tropical bird from the rain forest. Our senior lighting effects specialist, Dave Walvoord, created a brand-new piece of code to produce iridescent tail feathers via our procedural texture renderer." High-speed footage of real hummingbirds and videotape reference were provided to senior animator Doug Dooley, who executed the character work. "Seeing the genuine wing movement in slow motion gave Doug a good idea of the speed we wanted them to be moving; and that was key, since our bird was the first element completed for the sequence and set the tone for the remainder of it."

With the hummingbird elements well underway, the rest of the scene was still being worked out. "They didn't want a Hallmark card," Max Ivins remarked, "so the effect couldn't be too diffuse or idyllic or dreamlike. But it had to seem 'magical,' and capturing that was an elusive



Viewpoint DataLabs provided cyberscans of the actor, with the Blue Sky|VFX team then executing morphs between the scans and a Michael Westmore makeup to create the effect of tearing skin and crushing bones.

business.” After determining that ‘altered reality’ was as much a matter of depicting one’s mental perception of reality as it was a genuine physical reality, Ivins zeroed in on specific elements. “It was principally 2-D, comped over the live-action, although we also built a 3-D flower. Then there were light rays from the sun, animated to move slowly across frame as the plate colors altered slightly.”

A number of other enhancements went into the sequence; but in order to keep the frame from growing overly cluttered, many were omitted from the final shot. One that remained was a vertical stream of water near the couple. “When Anij touches Picard’s hand,” Cheryl Budgett recalled, “the stream begins to slow. At first we tried some turbulent morphs behind the water, but that made things look a little too surreal. In the final, we went with three or four layers of water, which suggested greater volume and created a more viscous look.”

While maneuvering through the Briar Patch, the Enterprise comes under heavy fire from a pair of pursuing Son’a battleships. The starship takes a severe pounding while ducking in and out of gaps in the nebula, but the next Son’a attack– using an illegal subspace weapon– tears a hole in the fabric of space that threatens to suck everything in the Briar Patch right out of the known universe. “The space tear was challenging,” stated Mark Wendell, “because the look for this ‘linear black hole,’ as they called it, was approved based on a still-frame image by Richard Kriegler. The matter element for soft Briar texture was very fine to begin with, so it was tough to animate the stuff to appear to shrink while still having enough presence to read. We wound up playing with the acceleration rates as this stellar matter reached the event horizon and disappeared, finally settling on a hybrid of techniques, mixing CG elements with some interesting practical elements provided by O’Connor FX, then pulling out all the comping gags to create a believable blend between these approaches.”

Riker saves the day by jettisoning the starship’s warp core into the subspace tear, where it explodes with sufficient force to cause space to fold back on itself, sealing the breach. Originally an entire sequence had been planned to show the core being blasted clear of the ship, with various safety hatches retracting into the hull or blowing away, but budget cuts led to the maneuver being handled via dialogue and off-camera. During its evasive maneuvers, the Enterprise exceeds safe travel speeds within the Briar Patch, causing its engine nacelles to smoke. “TD Andy Harris created that hot exhaust,” noted Mark Wendell. “A dense cloudy look was needed, so he utilized the Maya particle renderer to output particles as fuzzy volumetric balls, then overlapped them. It took a while, since the shadows are ray-traced, but the approach provided a solid and billowy cloud look, something Blender couldn’t handle with its softer render. Depending on the look required, we’d put particles through several different systems– we even used hardware renderers for a couple of elements that didn’t require much in the way of interactive shading.” Harris’ exhaust effect was so time-intensive a procedure that it could only be used to generate the foreground effect. In order to take these trails into the distant background, Richard Kriegler created additional smoke trails as digital matte paintings.

With few options left to him, Riker uses the ship's ramscoops to draw in explosive metreon gas from one area of the Patch, then turns back to confront the attacking Son'a craft. The Enterprise shears away at the last moment while Riker releases the gas, allowing it to envelop one battleship, which explodes. "The scoops- which were on the front of each engine nacelle- had been shown on the series a couple of times," Grower recalled, "but never with this level of detail. Production actually had to call someone in to explain the purpose and function and location of these scoops. We inserted a detailed section that irised open for shots of the gas being sucked in and spewed out." Andy Harris performed the particle work for the nacelle's expulsion of metreon gas, which was deliberately designed to resemble the cloud of ink left in water by a squid. As was the case with Enterprise engine smoke trails, the high number of swirling dynamic particles would have made for a rendering nightmare, so Kriegler once again generated multiplane background artwork that blended with the 3-D particles.

When Riker takes out the Son'a ship, pieces of the exploding craft blow back into the other battleship, severely damaging it. Working from files provided by SBS, Ian and Sherry O'Connor built a steel black buck of the Son'a vessel measuring about five by six feet, then rigged it for the pyro destruction, filmed at The Chandler Group by effects cinematographer Don Baker. The buck was suspended twenty-five feet above the ground outside in order to allow sufficient space for the resulting zero-g explosion effect. The pyro element subsequently went to SBS, where it was tracked against and composited over a CG battleship. To enhance the miniature blast, CG debris was also added. "I took a part from the first ship and rebuilt it as 3-D geometry, filled with girders," James Straus related. "I blasted this piece backward into the second ship, then animated it shattering into smaller pieces of debris that also impact and set off secondary explosions."

Much later in the show, when Hunter/Gratzner Industries became involved with the film's finale, this shot underwent further embellishment. "We kept the big O'Connor pyro from the debris hit on the front of the second ship and James' animated hit," Paul Wendell recalled, "but at HGI's suggestion, we added a kind of shockwave traveling through the vessel. That led to another O'Connor explosion blowing out the back side of the ship, which faces camera." To tie the series of explosions into the Briar Patch environment, Wendell dissolved back and forth



The success of Ru'afo's plan hinges on a Son'a science vessel designed to collect metaphasic particles from the atmosphere- particles that will rejuvenate his people, but render the planet uninhabitable. Cloth dynamics were developed and employed at Santa Barbara Studios to animate the collector's unfurling sails.



Aboard the captain's yacht, Data launches a trifling attack on Ru'afo's flagship, a diversionary tactic that allows the Son'a to be beamed onto a cloaked holoship, thus foiling their desperate plot. As with other spacecraft in the film, Santa Barbara Studios modeled and animated the vessels using Maya software.

between lit and unlit- though otherwise identical- Kriegler background Patch paintings, creating the impression of interactive light.

Back on the Ba'ku planet, Picard's group has at last reached the safety of the high mountain caves. But Son'a shuttles return and fire torpedoes into the mountaintop, attempting to drive the Ba'ku out of hiding by triggering a cave-in. The rockfall causes serious injury to Anij, but Picard is able to induce a state of 'altered reality' long enough for Dr. Crusher (Gates McFadden) to stabilize her condition. 'Altered reality,' in this instance, was depicted by slow-motion CG dirt falling from the cave ceiling- a standing Deep Space Nine set that underwent massive renovation, extending it nearly up to the studio permanent. Soon thereafter, Picard and Anij are tagged by darts from drones and transported aboard Ru'afo's ship.

Picard reveals to Dougherty that the Ba'ku and the Son'a are in fact the same race, though the technophilic Son'a had been exiled from the world a century earlier. Too late, Dougherty realizes he has been played by Ru'afo, who, weary of his dealings with Starfleet, forces the admiral into a facelifting unit in the body sculpture chamber, killing him grotesquely by pulling his face apart. Dougherty's death blended prosthetics, cyberscanning and morphing, with 3-D ripple effects and shadows added by BS|VIFX to sweeten the graphic scene. As a starting point, Michael Westmore's crew built a twisted face using hand-laid strands of hair to re-create Anthony Zerbe's trim white beard. Viewpoint DataLabs, hired to execute cyberscans of the actor in different facial positions, then employed in-house software that allowed them to create five NURBS surfaces- head, eyelids and ears- from the 350,000 points of data accumulated during a neutral face scan. From there, morph target points were created for Softimage animation. Then, to shoot the tail end of Dougherty's death, the set had been rebuilt on stage at BS|VIFX. "In the main unit coverage, there was no B-side of the prosthetic for after-death shots," said John Kilkenny. "We shot the B-side here, matching it to first unit's stuff, while adding dripping blood, scars and stretching skin. The scan data let us morph between the A-plate to the B-plate to complete the illusion of this killer facelift."

After ordering Picard's death, Ru'afo transfers to his science vessel, which houses a sail-shaped collector that will draw the metaphasic radiation from the planet's rings and bestow upon his people the beauty and longevity they have coveted. While the back end of the science vessel featured the injector- a device to be fired into the planet's rings to trigger a reaction in the metaphasic particles- John Eaves had originally intended the sails to deploy from prongs up front, an area inspired by the look of a badminton birdie. "At that point we'd planned to have multiple wings unfolding and a force field acting as collector," observed Eaves. "This blue glowing field would then direct the metaphasic particles onto the sails. It would have been more a visual effect and less physically tangible." But the sails underwent a number of additional art direction stages, necessitating their incorporation into and deployment from the main body of the science ship. Wanting to retain the interesting-looking prongs at the front of the vessel, Eaves converted them from sail armatures to engines.

The CG sails were produced with Cloth, a product simulating clothing dynamics developed by Alias/Wavefront and Physical Effects and incorporated into the rigid-body-dynamics Maya engine. "Some of the sail motion is based on a custom shader written by Ron Moreland," recalled Mark Wendell, "while other aspects come from the real dynamics you get with Cloth.

The basic principles are similar to those in Dynamation- a series of geometric vertices attached with spring calculations that apply to each specific vertex- and Maya has taken that spring idea from Dynamation and rewritten it to be more stable and less rubbery. But each patch of Cloth needed to be tacked at the edges, and the largest number of patches Alias/Wavefront had ever tested was four- a shirt front, back and two sleeves. Since the sails needed to be attached between all the ribbed structural elements on the collector vessel, we used upwards of forty- we gave it a real workout.” The sails were textured to resemble coppery-gold chain mail, though in the final cut of the film the surfaces- seen only at a distance- appear to be a continuous surface of grainy cloth.



A tractor beam contains Ru'afo and his bridge crew aboard the holoship.



Ru'afo discovers he is in a synthetic environment when he fires on the wall of what appears to be his bridge. Phaser and disruptor animation were complicated by the need for credible interactive lighting.

Picard manages to talk his way to freedom, and communicates his plan for foiling Ru'afo to Data and Worf. As the countdown to doomsday proceeds, the captain's yacht, navigated by Data, suddenly approaches, firing on the science vessel. There is a flash of light on the bridge, but Ru'afo, intent on rebuffing the attack, ignores it. Ru'afo watches on a viewscreen as the injector is fired into the rings and the metaphasic gas expands- a particle animation effect based on Richard Kriegler artwork inspired by the clouds of volcanic ash seen during the Mount St. Helens eruption.

Ru'afo initially believes he is seeing his plans realized. But after consulting sensors, he realizes it is all an illusion. Furious, the Son'a leader fires his plasma weapon into the wall of what he had thought was his ship's bridge, revealing a holo-emitter-encrusted surface beneath- that of the holoship, to which he and his bridge crew had been unknowingly transported by Worf during Data's attack. Cheryl Budgett utilized both 2-D and 3-D techniques for the holo-emitter reveal- with mattes, turbulence and particles employed to generate a 'going-on-the-fritz' look. Ru'afo beams to the science ship, from which he still intends to deploy the collector. Picard transports in to stop him, and a battle between the two ensues within the cavernous interior of the mile-long array as its sails deploy.

Blue Sky|VIFX took on the collector interior as a separate contract in late summer. "The whole third act had changed a lot from the time of our first bid," commented John Kilkenny, "and then changed again prior to the film's release. Frakes and Zimmerman had been limited by the height of the Paramount stages when building the live-action part of the collector set. That wound up being thirty-six feet high and maybe sixty feet across, so we extended its length to seemingly enormous proportions by adding a multitude of floors beneath the two figures." Greenscreen material was laid out on the stage floor so that the BS|VIFX digital extension could be attached to the live-action scene. "Even with the greenscreen in place, our guys still wound up with a ton of roto work every time the principals crossed in front of all that on-set pipework. For safety reasons, the main unit shot some of this on the bottom floor of the set; so due to the proximity of the backing, greenscreen contamination sometimes cropped up. We thought that some of the hairier shots- ones that had to be staged higher up in the set- would require wire removal on the actors, but both Patrick and F. Murray were troopers and did their work without harnesses from thirty feet up."



Blue Sky|VIFX compositing supervisor Cheryl Budgett and digital supervisor Max Ivins created digital extensions for the Son'a collector interior, enlarging the three-story stage set erected at Paramount. The pair also devised a variety of phaser animation effects, as well as many elements used in the film's 'altered reality' sequences.

To aid in developing a look for the most expansive CG views of the collector interior, Jim Rygiel scrutinized a study model of the exterior, built by Greg Jein. "The collector interior was like a scaffolding structure within a long tube," remarked Max Ivins. "There were beams and girders and light panels, so just painting that for a series of different 2-D shots would have been pretty painstaking. Instead we decided to build the interior in 3-D. That gave us a lot of flexibility in positioning the camera as well." The addition of atmospheric effects for the collector interior served to enhance the live-action.

For a time, depicting the enormous collector interior with an elaborate stage miniature was considered- somewhat ironic in light of the eleventh-hour effort that would soon go into creating a practical scale exterior collector. "Modelmaker Jim Key worked up a concept for the solar collector that included mechanical articulations," Carlyle Livingston stated. "There were going to be panels opening up with pivoting actions to deploy the solar sails. In terms of scale, we thought of the Forbidden Planet Krell chamber while extrapolating from John Eaves' exterior collector artwork, adding technobabble to justify various cool-looking aspects of the design." This physical model concept for the collector interior- with its numerous hexagonal openings through which stars could be glimpsed- would have used laser-cut pieces to create a repetitive pattern receding to infinity; but the proposal for a miniature was discarded when the number of shots featuring it was reduced to the point that costs for construction could not be amortized favorably.

As scripted and first shot, the fight sequence between the two principals climaxed with Picard yanking an ignition matrix from the collector, thus preventing its activation, while Ru'afo, trapped aboard the injector section, is fired toward the planet's rings. The Son'a leader's course was to take him into the metaphasic dust, causing a dramatic age regression that results in his utter physical dissolution and death. "It took us two weeks to prepare the Ru'afo de-aging," explained Michael Westmore, "and then they spent three days on stage shooting with a special camera. He turns his head in one direction, and by the time he finishes the turn, he's regressed to being a teenager. We had ten makeup changes spanning seven seconds, with morphs only coming on for a frame or two at each makeup change. For the last changes we used a younger man with an extraordinary resemblance to F. Murray, applying just a few nose pieces to make him a dead ringer. It was an amazing sequence that took place in a matter of seconds and cost a fortune, and I'd love to have seen it completed."

After a less-than-stellar test screening, Paramount okayed a more expansive- and explosive- finale. Although Picard and Ru'afo still remain within the collector, the captain now sets in motion a series of events that leads to the collector's fiery self-destruction. The Enterprise- having played a game of chicken with Ru'afo's flagship, carving it up using phaser-fire- swoops in and tracks along the exploding collector, only just managing to beam Picard to safety before he is engulfed by the blast, which kills Ru'afo. The ship-to-ship action was accomplished digitally by Santa Barbara Studios; but for exteriors of the collector's destruction, something more was needed. For that, SBS turned to Hunter/Gratzner Industries.

"We got a call from John Grower asking if we could deliver a gray buck of the collector in two weeks," Matthew Gratzner recalled. "I figured we could give them something more than that- a hero miniature with plenty of detail. The powers-that-be at Star Trek agreed to let me storyboard and design the sequence- which was really a necessity, since I had to come up with miniatures that could actually be fabricated in the limited time available. I always say that visual effects are not expensive- it is the lack of decision-making regarding visual effects that is expensive. Since there wasn't any time for interference with the creative process- it was more a matter of 'that sounds cool; go ahead and do it'- we were able to finish on time. Picard is at one end of the collector as he sets the self-destruct; and he can see all the way to the other end of the ship through this vast interior as it starts to blow, with the explosion coming towards him and the camera."

Gratzner's storyboards reflected a twofold approach to the collector demolition: an eight-foot miniature seen exploding for long shots, together with larger-scale panels blowing out in close views. Expediting construction of the eight-foot model was an innovative multi-team process. "Initially we were going to have to sculpt and cast a pattern for this ship," Gratzner remarked, "but I'd have pulled all my hair out figuring a way to do this plus the big panel pieces. So I thought of Innovation Arts- which is what became of the group of Mass.Illusion personnel who, instead of coming out west, stayed in Massachusetts. They've refined 3-D milling,

routing and cutting to an art, and were able to take pared-down files for the collector from Santa Barbara, then mill, cut out and ship all the parts to us- turning the whole thing around in less than a week. The foam buck pieces were cut from six-pound urethane foam, which did not take long- reading the files actually took longer. Initially they were going to send those on to us for molding, but Paul Clemente offered to do the molds and the jackets there before shipping. They had to run twenty-four-hour shifts, but still delivered on time." When the pieces arrived, Gratzner had steel bulkheads created to provide structural support. His crew built specific detail sections, which were then molded and cast prior to being adhered to the assembled buck.



Picard triggers a self-destruct mechanism aboard the collector, setting off a blast wave that races along the length of the ship. Hunter/Gratzner Industries- with logistical support from Innovation Arts- built an eight-foot miniature of the science vessel, which was then rigged with more than two hundred sequenced pyrotechnic charges by O'Connor FX. HGI crew members Brian Kelly Hahn, Tamara Walters, Forest Fischer and Michael Padilla apply final details to the model.



For a closeup view as the blast progresses, HGI built scaled-up panel sections of the ship, which were also pyro-rigged for destruction by the O'Connor team. Don Baker of The Chandler Group filmed the detonation shots.

To represent the open areas from which the sails have deployed, breakaway resins were used to create easily fragmentable detail.

While awaiting delivery of the Innovation Arts pieces for the eight-foot miniature, HGI personnel proceeded to build eight larger-scale breakaway panel sections of the collector. "It took a day and a half to fabricate the pattern for these six-by-ten-foot panels," Gratzner recalled. "There was a day to put it into rubber, and another spent making this huge, jacketed fiberglass mold before we went on to casting, where two panels were generated per day." The HGI crew laid up breakaway material with brushes, then delicately extracted the super-fragile panel pieces by inverting them and letting gravity help the rubber mold fall away from the casting. "We'd have six people running their hands against the edges for each part. Normally when you do jacketed molds, you can simply peel the rubber back, but the weight of the rubber would have caused it to collapse on itself. Around the perimeter we had also fiberglassed in a one-by-three wooden frame to provide structural integrity. The panels themselves- which featured key design elements from Greg Jein's maquette- were exceptionally well-detailed, with girderwork and trusswork beneath the surface so that when sections blew out there would be all this interesting material beneath that came into view. We used several different kinds of breakaway resins, primarily one type that had the brittleness of plaster, but not the dust. For each take we utilized three of these panels end-to-end, which created a six-by-thirty-foot section for each event."

The accelerated two-week construction schedule was immediately followed by a week-long pyro shoot at the Syncro Hangar in Van Nuys. Considerable planning had gone on between principals from Hunter/Gratzner, Santa Barbara Studios and The Chandler Group, all of whom interfaced directly with Ian and Sherry O'Connor to orchestrate the miniature pyro finale. "Originally I thought the larger panels would be eliminated with primer cord," Gratzner acknowledged, "but Ian and Sherry wanted smaller debris and a whole sequence of blasts that utilized a kind of forced-perspective approach."

During an earlier shoot for SBS, O'Connor FX had generated a wide range of explosions for generic use in the film. The destruction of the collector, however, called for a custom orchestration that required the O'Connors to draw upon techniques developed for but not used in *Starship Troopers*, as well as new methodologies featuring their own special fire solution, which provided excellent scale solutions and could be colored for stylistic effect. "There was such a limited time frame that we were only able to do one test on a full panel before we did the two big takes on the panel assemblage," recalled Ian O'Connor. "We built a sub-frame for our forty-two internal mortars and various explosives, atop which we later set the large HGI panel pieces. We also built special channels with internal baffling that helped contain and control the progress of explosions. We plasma-cut them to make them look like internal detail pieces of torn steel for the collector- you can't be too careful about what might show up during a high-speed pyro shot."

Don Baker Gratzner and the O'Connors hit upon the notion of opening up small panels on the larger-scale sections, pre-breaking them, then reattaching each piece loosely. "Sherry prepped the backs of the pre-broken panels on the large HGI pieces," noted O'Connor, "using flammable material on some. These would fragment as they were blown up toward camera. Other pieces

were treated with material that contracted when heated, so those would crumple and twist and melt while flying upward. They wanted the Enterprise flying right over the explosions rather than sailing on in front of them, so that meant keeping the hits very small, flooding the panels with slow-burning composition that caused debris to come only a little bit- maybe twelve to eighteen inches- off the surface. Those fireballs couldn't go too far up though, because then they'd cross into the area occupied by the CG Enterprise during its flyover- which would have been a roto nightmare. So we had to orchestrate a number of tiny blasts that moved across the surface. We had secondary explosions going off underneath that added jolts and some interesting colors. As the blasts came closer to camera, the events were spaced out a bit more, with the final six feet filled with primer cord to really demolish the thing. Between the foreground end of the model and camera, we put two big mortars that fired a big sheet of flame up under the lens, wiping the frame." One hundred twenty-eight separate charges were fired in a thirty-step sequence that took a mere three-fifths of a second in real-time- though the effect required more than eight hours to rig.

The sails are set ablaze by flaming ship debris. Although the solar sail element was CG, a physical fire element was needed as well. "We used a specially treated plastic film stretched over steel frames," O'Connor recalled. "The film was backed by pyro material, and we set the frame onto a latching box beneath that had fans and exhaust ducts built in. The pyro material on the back of the film was treated so we'd see some sparks and a bright burn, suggesting the sails are some kind of exotic material. When we ignited the pyro, the fans extracted all smoke, so only the burn element photographed- creating something like the burning map of Nevada on Bonanza's opening credits. SBS put that right over its CG sails."

The Enterprise races across frame just ahead of the blast, transporting Picard to safety just as the collector blows. "The eight-foot collector model had more pyro in it than I had ever stuffed into so small a space," O'Connor admitted. "There were seventy-two wires feeding into the model- and they all had to be protected since the heat of one explosion could cut or melt wires and destroy the continuity of this forward-rippling blast. Because we cut from the tiny panel hits on the large-scale sections, there had to be a ton of microscopic events added to the eight-footer to link the shots. We divided the collector into nine zones of activity, knowing we'd have to match the continuity from the panel hits while taking the explosion from the collector nose and coming back. The first event rippling along the ship was a series of over-volted lamps that Sherry dipped in amber to get a quick colored flash. That led the destruction, with the event following behind it utilizing a new kind of two-inch charge we prepackaged to drop right into the back of the model after it had been drilled out. The third wave was a larger series of blasts- about softball-sized- devised by Sherry using benzoyl. She found a way to prepack them that also allowed us to propel them upward through the surface of the model. From there we went to fireballs kicking the collector from within, while primer cord blew the whole thing to pieces."

Intent on preserving all of the great interactive pyro lighting on the miniature, SBS had worked with Don Baker to align the model in a position that would conform to that of their CG collector. "They shot it all anamorphic," related John Grower, "so to save time, instead of scanning at 4K and then squeezing, we scanned the squeezed image. We tweaked the position of our CG collector to correspond exactly with the miniature." The effect of debris blasting through the sails and burning them was accomplished with CGI, though lighting cues for the blast were all incorporated from the real flashes of the pyro explosion.

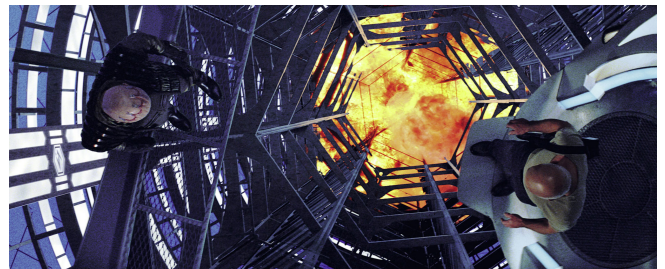
For added shots of Picard and Ru'afo within the collector, a reshoot was scheduled in early November, a month prior to the picture's release. Patrick Stewart had worn his hair extremely close-cropped in the film, but was now in a Broadway play for which he had let it grow out to two inches in length- a look he was contractually obliged to maintain. Rick Berman turned to Michael Westmore with the idea of fitting Stewart with a bald cap and wig. This proved impractical as the actor's fine hair was too short to re-create on a wig. Complicating matters further was Stewart's uniquely shaped, angular head. "It sinks in on the sides and is peaked on top," Westmore noted, "and those kinds of planes just do not lend themselves to a regular one-piece bald cap. But since we were only concerned with covering his hair, it didn't need to be a complete cap." Westmore dug out an old cast of Stewart's head from the series, copied it, then passed it to makeup specialist Richard Snell- a veteran of Trek feature film and TV efforts- for airbrushing.

Westmore and Snell, along with artist Camille Calvet, visited Patrick Stewart in New York a week prior to the reshoot to test-apply the partial bald cap. "We glued it down really tight over his grown-out hair," Westmore continued. "It fit him like a surgical glove. Then we came back with a flocking gun. A flocker rep had said that salt is what creates static electricity in hair, so we cut up the hair to lengths of sixteenth- to thirty-seconds-of-an-inch, then soaked them in saltwater before bagging them in an oven for drying. Then we loaded them into the flocking gun and shot them onto the cap."

Greenscreen shots of Stewart and Abraham were lined up and composited with pre-shot pyrotechnics of the collector interior exploding. A huge fireball racing up the interior towards them necessitated the construction of a miniature collector interior by Stirber Visual Network.



The Enterprise flies clear of the exploding Son'a vessel. For shots of the collector sails burning away, practical O'Connor FX pyrotechnics were enhanced with digital animation at Santa Barbara Studios.



For the interior of the exploding collector, Stirber Visual Network constructed a thirty-four-foot-tall miniature, over which Blue Sky|VFX added digital set extensions. The Stirber team also engineered a repeatable fireball effect that swept up through the miniature. Greenscreen elements of Patrick Stewart and F. Murray Abraham were composited over the digital collector and pyro miniature to produce the final shot.

“It was an eight-foot-diameter, thirty-three-foot-tall unit,” stated John Stirber, “painted black so VIFX could overlay their digital model afterward. The whole collector interior– all of the floors, handrails and latticework– was built from steel. That was the only way we’d be able to put fireballs up through the collector repeatedly without having it all go away each time.”

Working on less than a week’s turnaround time, Stirber ran double shifts with his fourteen-man crew to manufacture and deliver the necessary pieces. “In order to transport the model,” Stirber recalled, “we built the collector in eight four-foot sections, with a separate stand attached at the base that allowed oxygen to be directed in to drive the fireball upward. We never even had time to perform an assembly of the whole thing until setting up to shoot in a parking lot near VIFX.” Each take of the collector explosion was rigged as a sequenced event, utilizing primer cord charges to blow out structural elements on each floor while the fireball ascended.

With Picard back aboard ship, the villain neatly dispatched, and Starfleet belatedly backing the crew’s insurrection, the film concludes with Enterprise breaking orbit and departing back into the depths of the Briar Patch. “That was the first shot James Straus did on this show,” Mark Rendell recalled. “Whatever you give to James– be it a dragon in Dragonheart or the beast in An American Werewolf in Paris– he’s going to push the limits just to see where they are. So the first time he got to fly the Enterprise, James had the ship swooping around and up from the bottom of the Ba’ku planet, then doing a belly roll as it went past camera. The starship was moving like a World War II fighter plane– and it looked really cool– but it didn’t fly with the client at all.” The revised shot was considerably more traditional, with the ship crossing frame horizontally before receding into the distance.

Even as the Star Trek TV series have benefitted from all the sets and miniatures constructed over the years for the Trek feature films, the converse has likewise proven true. In addition to providing a wealth of standing sets that could be redressed, improved and extended, the TV series have produced a talented core group of Trek-savvy veterans, whose cumulative experience and collective knowledge of the franchise help guide the periodic movies, as well. “Nearly all of our testing for this film got squeezed in while we were working on Deep Space Nine and Voyager,” Michael Westmore asserted. “Whenever someone finished their morning makeups, they’d go off to experiment. If we’d had to bring people in from the outside for this, it would have cost tens of thousands of dollars– or more. Back on Generations, the studio asked me about hiring a group of feature film makeup artists. I told them that I had a brilliant staff from the series already on hand, and I wasn’t going to find new people who could do any more than this group. They can do anything they put their minds to– which is also true of the other series departments that contributed to the film.”

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THOROUGHLY MODERN MUMMY

image

ARTICLE BY ESTELLE SHAY

One of the earliest horror films to make its mark in the genre was *The Mummy*. Released in 1932, *The Universal Pictures* classic starred Boris Karloff as the Egyptian prince Imhotep, a reanimated mummy who rises from his plundered tomb upon the accidental invocation of an ancient curse. Though *The Mummy* would spawn, not surprisingly, a spate of similarly themed features during the next two decades, few rivaled the original. Six or seven years ago, however, Universal- spurred on by what has become an industry habit of dusting off old monster tales and giving them a nineties spin- began seriously entertaining the idea of a *Mummy* remake.

Numerous scripts were attempted, ranging from lighter, contemporary takes on the material to more horrific approaches, none of which caught the fancy of Universal executives. But in 1996, writer-director Stephen Sommers- best known for *The Jungle Book*, *The Adventures of Huck Finn* and, more recently, the ocean-bound thriller *Deep Rising*- contacted the studio with the idea of developing the property as a tongue-in-cheek adventure in the vein of *Raiders of the Lost Ark*. Engaged to write as well as direct the project, Sommers spent the next year completing work on a *Mummy* screenplay.

Before Universal would greenlight the film, however, studio executives wanted a firmer handle on the creature effects that were central to the story. For assistance, Sommers turned to Industrial Light & Magic and visual effects supervisor John Berton, an eight-year veteran of ILM, who first came on board as a character animator for *Terminator 2* and then went on to help shape the company's rapidly expanding



In *The Mummy*, a high-spirited remake of the 1932 horror classic, French Foreign Legionnaire Rick O'Connell (Brendan Fraser) teams with antiquities enthusiast Evelyn Carnahan (Rachel Weisz) and her brother Jonathan (John Hannah) to explore the ruins of an ancient Egyptian temple, in the process unearthing the mummified remains of Imhotep, high priest of Osiris. Director Stephen Sommers tapped Industrial Light & Magic to oversee design and creation of the mummy along with an assortment of other visual effects for the film.



computer graphics department through such films as Jurassic Park, The Mask and Casper. Having worked with Sommers the previous year on Deep Rising, when some of that film's complex character animation was farmed out to ILM, Berton remembered a discussion that would lead to the second teaming. "Stephen was still drafting the Mummy script at the time," Berton recalled,

"and he asked me what I thought the concept for some of the visual effects might be. The first words out of Stephen's mouth were: 'This is not going to be your daddy's mummy. No bandages. No shuffling. You're not going to be able to run away from this mummy. You're not going to be able to tear his arm off. This guy is going to be big; he's going to be bad; he's going to be the 'Terminator' of mummies; and he's going to cruise around scaring the heck out of everybody.' I told him to go for it."

In the fall of 1997, ILM commenced work on The Mummy as a proof-of-concept assignment. Berton- an aficionado of horror movies and an avowed fan of the Karloff mummy film- relished not only the idea of a remake, but also the opportunity for design input in the earliest stages of the project's development. "It was a tremendous opportunity to do something that we've wanted to do for a long time with our effects work here at ILM," Berton commented. "We've always had the capacity to do design work, but oftentimes in preproduction the studio will hire a creature designer. Obviously, there are tremendously talented people capable of doing that- but we have those skills here as well. We really wanted to show what we could do."

For his retelling, Sommers had let his imagination run wild. The script had all of the original film's epic scale, romance, and creepy atmosphere, but this time with a modern twist. Its spirited hero, French Foreign Legionnaire Rick O'Connell (Brendan Fraser), a character cut from the same cloth as Indiana Jones, and the indomitably spunky Evelyn Carnahan (Rachel Weisz), a young librarian determined to make her mark on the archaeology world, would lend a tone of cheeky humor and good-old-fashioned fun to the proceedings. Setting out across the desert in 1925 Egypt, the pair- accompanied by Evelyn's playboy brother Jonathan (John Hannah)- undertake an expedition to locate Hamunaptra, the ancient city of the dead, a site rich in artifacts and where a king's ransom in treasure purportedly lies buried. Racing across the Sahara neck-and-neck with a competing expedition, they stumble upon the ruins hidden deep within a volcano. There, the rival teams vie to excavate the site, unearthing in the process a sarcophagus containing Imhotep, a 3000-year-old mummy, buried alive in a manner reserved for the most reviled of blasphemers. When an age-old curse is set in motion by Evelyn's utterance of an ancient incantation, the mummy- little more than a desiccated corpse- awakens and swiftly begins usurping human body parts in order to transform himself from a decayed skeleton into a formidable, and nearly unstoppable, superman.

The task of conceptual development was handed to ILM's in-house character design team, led by Jeff Mann. Joining artists Benton Jew, Derek Thompson, Brian O'Connell, Miles Teves and Carlos Huante was effects art director Alex Laurant. To accomplish Imhotep's metamorphosis, Sommers and Berton had in mind the creation of a computer generated character to represent

An opening sequence, where a mummy is reanimated, the hero is shifting sands of land, and the mummy's aid in the effect. Explosive live form of the mummy's shaking of ILM through a combination of model work, matte paintings, bluescreened live-action and location photography. Modelmaker Carol Bauman adds paint touches to a sphinx- ostensibly still under construction.

the mummy's earliest stages, to be replaced by a real actor as the transformation progressed. The mandate for the design work was to create something visually new and interesting in terms of the film's central 'walking corpse' notion. "The mantra we kept hearing over and over again," said Laurant, "was that this was not to look like a man in a suit or a prosthetic makeup. They wanted something so decayed that it was practically transparent, even though it was still alive and breathing."

The opportunities to push the envelope on character animation were by no means lost upon Berton as the design efforts got underway. "With this project," Berton observed, "the thing we wanted to do particularly was to take a humanoid figure and bring him to the screen in a way that was more organic, more realistic and more effective than anything we'd done before. Every time you approach a creature project, you try to find out what's important about that creature, and in what ways you can improve upon what you've done in the past in terms of bringing realism to the screen, both in rendering and in the way that a character moves and behaves. It takes a tremendous amount of sophistication to get character animation to look right; and the closer you get to a human figure, the more difficult that becomes. But the advantage here was that we had control over the design. We could decide exactly where to push the envelope because we knew our own capabilities and limitations. We could spend more time making our creature look tremendous from the ground up and less time having to match some preexisting concept."

Brainstorming ideas over the course of several months, the design team produced volumes of black-and-white pencil art in order to pin down a look for each of four successive stages of mummy regeneration. Stage one was the character at his most grotesque- essentially an animated skeleton with layers of muscle and bare sinew visible, along with dangling bits of skin fused with the tattered remnants of bandages. Internal organs such as the brain and intestines could also be seen through holes in the head and body. Stage two had the mummy somewhat regenerated, with areas of fresh skin and musculature covering the torso and face, though major areas of desiccation still remained. In the third and fourth stage designs, the regeneration was nearly complete, except for see-through areas in the face, neck and chest. "Conceptually, an important part of the whole design approach," commented Laurant, "was to distinguish this mummy from all the other classic mummies. He is not a stiff, crusty, bandaged guy who just hobbles around. Stephen wanted audiences to realize just how threatening this guy



Helping set in motion an ancient curse surrounding the unearthed mummy, members of a competing archaeological expedition come under attack by swarms of locusts in the first of ten biblical plagues revisited upon the land. While ILM created the swarms digitally with particle animation, a closeup of the expedition's Egyptologist inundated by the insects employed

is, and how strong. That was part of the regeneration gimmick throughout the movie. By the time he gets to stage two, he's started to show signs of what we called 'buffitude'— a factor that played very heavily into the designs. So we pushed the weightlifter, superman look and played with that line quite a bit— just how pumped-up he was going to be without appearing too cartoony. Even

though there are still huge pieces missing that haven't regenerated yet, he's changing and he's very threatening. By stage three and stage four, it's the actor with not quite a full face replacement. The idea is that, at this point, the mummy is working up towards a pretty complete state. If the camera sees him from the side, he could conceivably pass for what someone might call handsome. But the gag is that whenever he comes into physical contact with a live person, it sends that part of him rotting back to stage one."

The hand-drawn, black-and-white artwork by the character design team next was expanded upon in color. Working from photo reference of actor Arnold Vosloo, who by then had been pegged to play the mummy in his more advanced stages of regeneration, Laurant scanned the material into the computer and produced a variety of computer generated color concepts in Photoshop. "At that point," Laurant recalled, "the film was getting greenlit, and the studio wanted to see how the creature would appear in a fully-lit scene, with light coming through the holes in his body and head. Those were the first real pictures of the character in a scenic environment. When we started developing the designs, it was actually before Arnold had been cast, so we were all working in the dark as to what the final facial type was going to be. In stage one, not enough of the face and body had regenerated to really recognize Arnold's likeness; but the skull type and basic set of the face did need to have continuity throughout all four stages. So that's something we refined a lot more once we got a digitized version of Arnold and a solid idea of his physique and bone structure. We ended up modifying the designs a bit, since Arnold had a broader face than our original Imhotep." To supplement the artwork and provide reference for the digital team, detailed sculptural maquettes were also crafted in the model shop by Richard Miller, Michael Wick and Danny Wagner.

By early 1998, Universal had approved the concept work and given The Mummy a thumbs-up for production. Working in conjunction with ILM would be Chris Corbould, recruited to handle on-set physical effects, which included an assortment of interactive gags for the CG work. Also deeply involved was makeup veteran Nick Dudman, charged with overseeing all of the practical makeup effects, which ranged from animatronic body parts and prosthetic makeups for Imhotep and a wide assortment of other characters, to dummy corpses, to full mummy suits for an army of the dead that are resurrected in a climactic battle sequence. Throughout preproduction and production, Dudman would work in close collaboration with the ILM team, since all of the practical makeup effects involving Imhotep had to take their cue from ILM's designs. In contrast, Dudman's design and execution of mummy suits for the battle sequence would guide ILM's CG work in that area.

both digital locusts and real, anesthetized insects affixed to actor Jonathan Hyde's face and body. Embedded in the phantoms surrounding the mummy inside the completed animatronics were made with proprietary software to efficiently render a clean index of the face geometry, and created a scuttle cycle applied to particle systems in Maya to direct the scarabs' mass movement over a variety of irregular surfaces.

With principal photography slated to begin in the spring, ILM began gearing up for what promised to be a complex and technically demanding show. “A great many things had to be sorted out,” Berton remarked, “and we had only two or three months to get ready for the shoot. We had to decide what we needed to shoot, how we were going to shoot it, what we needed in terms of effects, and what kinds of R&D there needed to be, so that when we got the plate photography in we could hit the ground running. A tremendous amount of effort went into just figuring out logistically how to approach all of the technical problems we knew we’d have to solve.”

Of chief concern were thirty-five shots featuring the early-stage CG Imhotep. Besides the obvious challenge of rendering an anthropomorphic character with such complex see-through detail, the digital team also had to cope with matching their character’s performance with its real-life counterpart in the form of Vosloo. Then, for another ten or twelve shots featuring the actor as Imhotep, ILM would be required to digitally remove portions of his face, neck and chest, replacing them with computer generated prosthetics to represent areas of the mummy that were still decomposed. Also consigned to ILM were some one hundred shots entailing mostly non-creature effects, many as ambitious as the creature undertaking. Such effects ran the gamut from matte paintings and models for an opening prologue that established the ancient Egyptian origins of Imhotep, to digitally engineered sandstorms and plagues. Furthermore, an action-packed finale would require augmenting live mummy performers with scores of CG counterparts.

Principal photography for *The Mummy* began in May 1998, on location in Morocco, which doubled for the Cairo and Hamunaptra exteriors and offered dramatic backdrops for expansive desert scenes. From there, the production moved to England where a number of sequences involving a labyrinthian underground necropolis were filmed on elaborate sets constructed on soundstages at Shepperton Studios. Throughout the shoot, Berton and a team of ILM camera technicians and artists were on hand to orchestrate the plate photography and gathering of survey data for the planned digital effects. “Fortunately, we had tremendous support from all of the people on the production,” stated Berton, “from Steve Sommers to visual effects producer Jennifer Bell, to editor Bob Ducsay and director of photography Adrian Biddle. Everybody down the line was very attentive to the idea that in order to make the effects as good as everything else in the movie, they needed to give us a chance to go in and do the things we wanted to do. Our match-mover



Still alive after 3000 years of entombment, the decomposed Imhotep confronts Evelyn, whom he mistakes for his lost love, Anck-su-namun.



Marla Selhorn and her team did a tremendous job of gathering all the camera match-move data. Marla measured absolutely everything- in every setup in every camera position. We joked that you could ask Marla about anything in England and she would know how tall it was.”

While the production was underway, a major R&D effort was also in progress at ILM. “There were a lot of things in the movie that required very technical kinds of computer solutions,” related Berton, “and we had to get all those things lined up to go so that when we got back with the photography we’d have a leg up in terms of how the images would all be put together.” Such technical complexity would demand a well-coordinated effort and closer-than-ever collaboration across disciplinary boundaries. In Berton’s absence, effects producer Tom Kennedy and CG supervisor Ben Snow took up that challenge, assembling the CG team and overseeing the R&D work. “With a character as complicated as Imhotep,” Kennedy commented, “we had to make sure that everyone was working from the same page early on. Our design development team and our CG team had to interact with each other so that as the look of everything was developed and refined, we knew whether we could or could not execute that in the CG world, or what we would have to invent in order to do it. For our virtual Imhotep, that included moving muscle mass and skin- things that have been done before in certain ways as cheats, but that here had to be done very true-to-life, in full anatomical detail, so that the character could hold up on camera for long periods of time.”

An essential element of the research centered on the development of proprietary procedural tools for animating the CG mummy. “We usually build creatures and simulate the movement of muscles sliding under the skin by sculpting things that sort of look like that,” explained software engineer John Anderson, who oversaw a development team that included Vishwa Ranjan and Nicolas Popravka. “On this show, though, we really couldn’t cheat that because you could see through a lot of the character. You could see the stuff inside him. We were going to be painting holes in the skin, so you could see the muscles moving underneath and how the skin and the muscles worked together, and what the guts were doing. It’s not very often that you have to worry about what somebody’s intestines are doing, or what his brain looks like moving inside his head.” Such see-through complexity would require a more subtle level of animation to sell the idea that Imhotep in his early decayed stage was alive. “We had to make this creature look organic. There had to be enough happening to give the impression that you were looking at a real creature made of bones and muscles and goo and whatever, with stuff wrapped around that. The whole thing needed a kind of resilience and tension that just worked together as an organic whole. It’s that subtle softness you get when things are moving just a little bit. If you don’t have that, it tends to look a lot like a puppet or an action figure; and we really didn’t want that.”

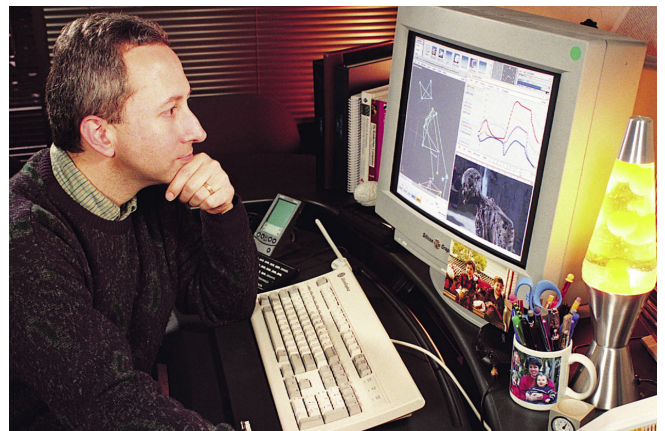
The highly detailed and complex digital character of Imhotep was a significant challenge for the team. The character was designed to be a mummy, with a focus on the decayed and aged appearance. The team used a combination of traditional sculpting and digital techniques to create the character's skin and muscle structure. The character's movements were also a key focus, with the team working to make the character feel like a real, living creature. The final result was a highly detailed and complex digital character that brought the story to life.

The application of procedural tools in character animation was a relatively new development at ILM, having initially been put to the test in the creation of realistic hair dynamics for its CG gorilla in *Mighty Joe Young*. “The cape in *Spawn* was done procedurally with *Dynamation*,” Anderson noted, “but *Mighty Joe Young* was really the first time we did a major in-house R&D effort for procedural animation where it was a significant part of a movie. So it’s been a continuing development in the philosophy of how we do this stuff, progressively applied to increasingly more difficult geometries. With procedural tools the motion is algorithmic. There’s a mathematical model for the movement. It’s not automatic movement in the sense that it’s not guaranteed to be plug-and-play– there’s actually quite a lot of effort that goes into some of these shots. But it’s automatic in the sense that there aren’t individual animators moving little bits of skin or dangling bits around all the time. The look you get with procedural animation is very different. There are thousands of little pieces of independent motion; and when you see it, you get a sense that you’re looking at something that has some life to it. But it’s very subliminal. You’d go mad trying to hand-animate it.”

For *The Mummy*, the R&D team devised an entirely new skinning technology that provided sophisticated simulations for the movement of skin over muscle. “We have a mathematical representation in the model for all of the stuff that fills up the spaces, and also the skin and the dangly bits,” said Anderson. “But nothing moves at that point. We don’t actually do the simulations until the primary animation is done. It’s a secondary stage that’s added afterwards. So we had to integrate this system into our software pipeline. We had to be able to construct objects, calculate their motions, and get it in terms of something we could render. That’s what Nicolas, Vishwa and also Cary Phillips did. They were critical in terms of getting this new level of procedural animation into our whole pipeline.”



Technical animation supervisor Dennis Turner devised a means of imbuing the computer model of Imhotep with realistic muscle movement, driven by the movement of the skeleton. The sophisticated muscle technology was one of several innovations incorporated into the model. Others made use of breakthrough procedural animation tools– developed by an in-house software team– that simulated the subtle, but essential movements of skin, flesh and organs.



Inventive use of motion capture by ILM was also instrumental in ensuring that the performance of the virtual character would match that of actor Arnold Vosloo, portraying Imhotep in his more fully restored human state. Jeff Light, who headed up the motion capture effort, examines some of the captured data retrieved from sessions conducted concurrent with the main-unit shoot at Shepperton Studios.

The skinning technology represented an important breakthrough in the attendant push for increasingly more sophisticated character animation. "Ultimately this is the way we're going to build all of our creatures," Anderson commented. "It's the next level in creature realism. In *The Lost World* or *Jurassic Park*, when a dinosaur walked along and its skin jiggled, that was all done by an animator sitting there, using manual tools to move the skin up and down in places. Now we can do a lot of that procedurally to sell the shot. It's going to be a key element in future character animation as the bar keeps getting raised. Every time we do a project, we have to generate pictures that look better than the last time; and now that we're rendering creatures that have this level of visual complexity, we have to be able to add that kind of subliminal detail."

Besides plugging the new skinning systems into the model, technical animation supervisor Dennis Turner oversaw numerous other complex problems involving the CG model construction. "This was not a show where we could depend on standard creature procedures," Turner observed. "It was kind of NASA-style building versus Volkswagen. It's like someone handed us an aluminum block, and said: 'Here. We need a car.' Everything was custom. Everything had to be done from scratch, and required somebody to look after it and make sure things didn't go completely awry. The technical problems alone were so deep, they required my full-time attention." One such problem was the need to rig the animation model for realistic muscle movement. The muscle technology- which Turner had previously developed for *The Hulk*, a project on which considerable R&D effort had been expended only to have the film be shelved- was also procedural in the sense that it defined how the muscle shapes would change as the creature moved. "We rigged the model in such a way that the muscles attached to the right spots on the bones and would pull, twist and flex realistically, driven by the movements of the skeleton. It was tremendously challenging to get all that stuff to actually function and work together, because nothing in CG actually touches. We had to make it look as if everything was touching, as if one muscle was hitting another or pulling on another. Rick Grandy was the key person responsible for doing all the enveloping of the muscles. He was my right-hand man and just did a fantastic job."

Model supervisor James Doherty and a crew that included Wayne Kennedy, Edward Taylor, Omar Velasco and Paul Theren, were charged with construction of the model geometry. Working from the inside out, they built up the layers of bone, flesh and skin for the stage two *Imhotep*, then sculpted that back to create the stage one version. Although the two models were very different sculpturally, the underlying geometry of both stages was kept identical in order to facilitate an on-screen transformation that had to occur from one stage to the next. The completed model contained more than 600 surfaces- 182 bone surfaces, 207 flesh surfaces, 152 skin surfaces, 20 wraps and 48 bits of hanging flesh. Because of the extreme degree of sculptural detail required, much of the model's definition was added in the paint stage. "Imhotep had so much detail and so many pieces to him, it would have hindered us greatly to build all of that within the model geometry itself, as we usually do," explained CG supervisor Michael Bauer. "The geometry would have been so dense, it would be unmanageable." Instead, the model was handed over to lead viewpainter Catherine Craig and her team. Craig used paint to add texture and depth to the surface of the model, generating the intricate bumps on the

skin, holes in the flesh and head, riveting in the muscles- all the details that gave the creature its horrific appearance.

With the maquettes and drawings serving as reference, Craig added more than three thousand surfaces of paint using color maps, texture maps, displacement, specular and opacity maps. "I could make the veins come up, or cracks go in by utilizing different levels of displacement," explained Craig, "which are essentially data maps painted to make the geometry move. One of the things I used the most was opacity mapping, which allowed me to cut through different surfaces of the model to create holes. I could cut through the outer skin layer to the underlying flesh, and maybe through a little bit of flesh as well. It would have been really difficult for Jim Doherty to create all of those holes in B-spline geometry, so I created them in paint. Then I utilized displacement in combination with the opacity maps in order to achieve a feeling of roundness and depth and volume to the flat sheets of geometry. Without that, the edges of the holes would have looked flat, as if I had just stamped through the surface with a cookie-cutter."

Since the viewpainters lacked adequate visualization tools to check their work, they often had to render the model to see how the different paint techniques interacted. "It all changes in the render," remarked Craig. "I found it analogous to doing pottery, where you paint with this magenta glaze, having been told that the magenta will become a beautiful cobalt blue once it's fired, and you don't really know or believe it until you open the kiln the next morning. This was very similar. When you're combining three levels of displacement, plus opacity and layers of geometry onto the model, a lot of times you just have to play around with it. Every day was experimental."

Once the model was painted, a low-rez version was handed over to the animation team- under the direction of animation supervisor Daniel Jeannette, whose job it was to craft a believable performance for the character. It had been Berton's intention from the start to utilize motion capture in the animation as a way of ensuring a level of continuity between the performance of the virtual mummy and that of Arnold Vosloo. "We set off from the very beginning to push the envelope on motion capture," Berton remarked. "I had always felt that it was underutilized, that people looked at it as a shortcut or cost-saving measure, or as a way of doing background characters. Or they saw it as some sort of artifice that prevented you from utilizing the talents of animators. We certainly didn't want to infer that, because our animators bring so much to what we do in computer graphics. They're the ones who understand motion, understand what needs to come to the screen. Without talented, expressionistic artists driving the character animation, you're going to get something that looks stilted and unreal.



In a Cairo marketplace, Imhotep retrieves from his latest victim a canopic jar containing the organs of Anck-su-namun, whom he intends to raise from the dead. The victim's shriveled corpse was one of numerous dummy bodies supplied by Nick Dudman, who provided all of the film's practical makeup and creature effects.



Prosthetic makeups devised for the marketplace scene, shot on location in Morocco, included special LED markers incorporated into cheek and neck appliances affixed to Arnold Vosloo. The markers tracked the movement of the actor's face in 3-D space to facilitate the subsequent application of computer generated appliques representing still-rotted areas of Imhotep's face and neck.

“But here we were trying to emulate exactly an existing performance. We knew we were going to have Arnold at the end of the film as the mummy, and we knew we’d have a completely computer graphics version of him walking around at the beginning. So I thought if we could get Arnold into a motion capture suit performing his own character, and capture his characteristic gait, his gestures and his movements, we could use that to ensure that the qualities unique to Arnold would be intrinsic in our creature as well. To me, that was the whole key. So I said: ‘Let’s push the technology. Let’s make it good enough to strut out our hero character right into the camera. Then let’s complement that with the expertise that we have in terms of doing character animation for the fine expressions of the fingers and the face, and layer that on top of this incredibly good data to give us something really interesting.’”

With that strategy in mind, Jeff Light, who headed up the motion capture team, made preparations to conduct capture sessions while first unit filming was still underway. Light, who had spent three years developing capture-related technology for ILM, packed up the company’s Oxford Metrics Vicon motion capture equipment and transported it to a soundstage at Shepperton. Accompanying him were Doug Griffin and Mike Sanders, tasked with overseeing all of the technical aspects of the shoot, and Daniel Jeannette, who would work alongside Berton and Sommers on set to address performance issues. “It was an incredible testament to Jeff and his team,” commented Berton, “that they were able to take what had been a very carefully calibrated system and export it across the ocean, set it up in two days, and do some of the best, most accurate motion capture that anybody has ever done.”

Scenes designated for motion capture were first rehearsed on the real sets with Vosloo substituting for his CG counterpart. “We walked Arnold through each scene and photographed his performance,” Berton explained. “That accomplished several things. It gave us a feel for the space and what we wanted in terms of the motion capture, and it gave us all- particularly Stephen and Arnold- a clear idea for blocking out the shots and for what the background plates needed to be for the action we wanted to create. So we treated the motion capture pretty much like you’d treat photography.” Once the plate photography was shot- minus Vosloo in the scenes- the camera moves were put into the computer and that information was used to help block the motion capture. On the motion capture stage, Vosloo, wearing a standard motion capture suit with markers attached at critical pivot points, reenacted the scenes as eight video cameras captured the performance from different angles. “Instead of standing on a set, Arnold was in a relatively empty space, with masking tape all over the floor, going through the motions. Then we’d take that information into the computer and recomposite it over the top of the background plate to see if what we were capturing was working for the shots.” Besides Vosloo, ILM also captured elaborately choreographed moves of stunt performers for the end-battle mummy brigade.



A swarm of flies, computer generated by ILM, spew from the mouth of Imhotep and spread through the Cairo marketplace. The essentially live-action shot called for a CG prosthetic to replace the entire lower portion of Vosloo’s face, animated to hyper-extend in grotesque fashion.

Upon completion of the four-day shoot, motion capture supervisor Seth Rosenthal took over for Jeff Light at ILM, working with animators to get the most out of the captured data. "This show was really a breakthrough achievement in motion capture," stated Rosenthal, "just in terms of the volume of capture that was done on characters that were front-and-center on screen. Because those characters were going to be so large and have so much exposure, the fidelity of the motion capture data had to be higher than anything we'd done before. So the first thing we had to do was clean the data. We used some of Vicon's off-the-shelf tools to reconstruct it, then brought it into our own software pipeline for refinement. From there, Daniel Jeannette and the creature team employed a variety of fairly sophisticated techniques for taking the clean data and fitting it to the character performances."

One technique that proved useful was a proprietary tool, developed in-house by John Horn, that enabled animators to edit motion capture files by stringing them together, creating a single, smooth performance. "We could blend different pieces of data from our capture sessions to create performances that were unanticipated," Rosenthal elaborated. "So if there was an aspect of the performance that, for whatever reason, didn't get captured- it fell through the cracks, or maybe an artistic decision was made later to reframe the scene- we could go back and roll up our sleeves, and say: 'Okay, we have this piece and that piece. If we can blend them together in an effective way, we can have a new performance.'" Another device- a quick-and-dirty production tool developed by Rosenthal- enabled animators to handily change the timings of motion-captured performances. "If you needed a character to hit a certain mark sooner to match with other elements in a shot, you could go in, and say: 'Okay, I want this particular action, at frame 180, to occur twenty frames earlier,' and this tool would retime the entire motion smoothly so that the first part would be sped up to hit that mark, and the rest of it would slow down until it ended on the same frame."

On the whole, animators found ways to balance and blend the motion capture data with key-frame animation to create a hybrid performance that effectively utilized the best of both techniques. "What we found was successful in terms of motion capture," observed Jeannette, "was everything that was action driven- like a character walking or fighting. Anytime it came down to more subtle movements- like postural things or gestures- that's when we used key-frame. It took a bit of adjustment to understand the technique and its limitations, and to assimilate the way of using it to the benefit of the show."

Essential aspects of the character performances that were strictly key-frame were facial animation and hand movements. Animators used Caricature, ILM's proprietary facial animation software, to create all the subtle nuances of Imhotep's expressions and eye animation, essential ingredients in selling the performance. "There is technology available to capture facial animation," Jeannette acknowledged, "but it's not quite at the level we need yet. Also, the problem with Imhotep was that the early-stage character didn't bear much relation to the face of Arnold Vosloo; so it would not have been all that useful." Lip-syncing for scenes in which the character was called upon to speak was especially tricky because the facial decomposition on Imhotep was so extreme that there was not a lot of face left to animate. Animators relied on a library of phonemes developed by the creature team to produce the mouth movements

necessary for speech. However, because Imhotep's lips were virtually nonexistent and there was a big hole in the cheek, certain mouth positions had to be heavily cheated.

Jeannette also found himself frequently treading a fine line between Sommers' desire to go beyond the structural limitations of the human face and his own reluctance to make it too broad. "Stephen wanted the mouth to open really, really wide whenever Imhotep let loose with his primordial shriek," Jeannette recalled. "Trying to get a handle on what looked convincing without its appearing too cartoony was tricky. For some shots, we ended up really stretching the limitations of what a mouth could do, animating all the little pieces of flesh that dented and shifted when he smiled or talked- which was very time-consuming. It took a lot of intricate painting, comping tricks and rendering and lighting to make everything work; but we had a great animation crew- led by Jennifer Emberly, who oversaw all the day-to-day intricate and creative issues. Considering that our animators were fairly new to the medium, the level of realism they achieved was stunning."

Once the primary animation was completed, it was handed off to a team headed by CG supervisor Michael Bauer for final rendering and lighting. At that point, preliminary renders were created and secondary procedural animation added. "The preliminary renders gave us a baseline to see what we were working with," stated Anderson. "John Berton would look at them, and go, 'Well, this one gets brains and guts and dangly bits.' Then we would generate the motions for that and do whatever tweaking needed to be done. A lot of the magic in the simulations had to do with how we finessed them. There's no black box, where you drop stuff in and out comes a shot." Rendering the character also required substantial finessing by Bruce Powell and David Hisanaga, who developed the look and lighting of the stage one creature, and Keith McCabe and Vinh Le, who were similarly responsible for the stage two version. "There was a lot more complexity of detail in this character," noted Bauer. "We had to light him so that you could see through the rotted skin, through the rotted flesh to the bone and, where there were holes in him, through to the background. So we really had to do things you wouldn't expect to with an ordinary model- like taking extra care to place beauty lights that



The fully regenerated Imhotep steals a kiss from Evelyn only to discover that the physical contact causes the lower portion of his face to revert back to its former decayed state. The on-screen retrogression was achieved as a 3-D reveal, utilizing advanced shader techniques to expose successive layers of decomposition- from outer skin down to bone- within a timed sequence.



Several shots of Imhotep in his post-kiss state made use of the computer generated see-through jaw, precision-tracked and blended onto Vosloo's moving face, and animated for realistic expression and lip-sync.

accentuated the see-through qualities, or adding kick lights where there were holes, to catch the back edge of the ribs. We also had to light the mummy so that you could differentiate between the layers of bone, skin and flesh. If you couldn't see enough of his flesh, for example, we would cheat in a light that only hit the flesh, to add a little specular kick."

One of the most challenging shots involving the CG mummy was a scene calling for Imhotep to transform on screen from one stage to the next. Having absorbed the essential body fluids of his latest victim, Imhotep undergoes a metamorphosis from his skeletal stage-one to his vastly more powerful stage-two form. In the graphic, ten-second transformation- realized as one long, uninterrupted shot that moves from a wide view of the mummy writhing and contorting in pain to a closeup on various parts of his body- bones bulge, musculature is seen bulking up and skin knitting together over the top. Technical director for the sequence was Amelia Chenoweth, with Greg Kyle and Sharonne Solk handling the animation. "It was very similar to a scene we did in *Spawn*, where Clown turns into Violator," commented Dennis Turner, who was also instrumental in creating the shot. "For the most part, like *Spawn*, it's just one long transforming shot, with everything right there in front of you, and no cheats possible. Also like *Spawn*, we employed a kitchen-sink type approach, throwing everything into the mix. There are transforming texture maps and transforming shapes, plus dynamic simulations and flesh simulations. And because a lot of it was based on Arnold's motion-captured performance, we had to choreograph the transformation to fit in with the movements of the actor. For example, there are places where we start off looking at Imhotep's back, then he jerks and turns and we're looking at his front. So we tried to showcase different areas of him changing wherever it seemed most appropriate in the context of the action."

As the plate photography became available, some of the first scenes entering the pipeline at ILM were those requiring the application of CG prosthetics to the face and neck of Arnold Vosloo. "In the story," explained Bauer, "the mummy continues to regenerate. But then he kisses Evelyn, and there is another on-screen transformation where his mouth rots. So in the next series of shots, he has this decrepit, chewed-up face, even though the rest of him is just Arnold playing the part." Shots involving the digital face replacement were among the most technically demanding in the show, requiring match-movers headed by Terry Chostner, and compositors under the super- vision of Scott Frankel, to track and blend, with surgical precision, the digital appliqué onto the live-action actor. "There are certain kinds of effects that are a lot harder than they look, and this was one of them," noted Berton. "It's hard enough to take a synthetic character and move him across a set; but at least in that instance, the floor is holding steady and you know kind of what the camera is doing. Imagine having to move him across the undulating surface of something- that's pretty much the problem we faced in terms of having to place digital prosthetics onto Arnold Vosloo's face." Sommers had, in fact, employed a similar gag in *Deep Rising* for a scene in which the still-living victim of the sea beast is regurgitated in a semi-digested state and staggers about. The aptly named 'half-digested Billy' had been one of the film's most arresting images. But whereas that relatively minor character had been on screen for mere seconds, the digitally altered human ILM would be called upon to produce for *The Mummy* would appear in numerous shots and have more than a full minute of screen time.

Nightmarish as it was, the task was ameliorated somewhat by efforts undertaken to track the movements of Vosloo's face in 3-D space during live-action photography. For scenes requiring the digital face replacement, special tracking markers had been designed and built to ILM's specifications by Nick Dudman, and incorporated directly into the prosthetic makeups worn by the actor. The self-powered devices consisted of light-emitting diodes that gave out a particular level of red light when positioned at exactly ninety degrees to the plane of the camera. "We had a cheek section that had lights in it," Dudman explained, "various circular reflective disks for the lips that picked up lip movement, and a triangular section that went on the side of the neck above the collar bone. The positioning of all of those pieces had to be measured in micrometers after every single shot, to be absolutely certain that I wasn't slightly off in my applications from one scene to the next. Because if ILM was trying to lock onto something, and they got to a shot where the prosthetic was half a millimeter off-kilter, that would have been a serious problem."

Although the tracking devices provided valuable visual reference, the match-move and compositing teams faced an incredibly difficult and time-consuming task. Even the slightest slippage would give the trick away. "We could track the orientation of Arnold's face," commented Berton, "but we couldn't track the tiny muscles in his face that made him smile, or the expression that he used when he was angry. All those kinds of things moved the face in very subtle ways. So our compositors had to go in and slowly and carefully try to blend the edges into those little things that we were able to perceive; and because we were trying to match a three-dimensional object onto a two-dimensional picture, there were variances. When there were, we'd have to go back and track those again."

Nowhere were such challenges more in evidence than in the scene where Imhotep kisses the sleeping Evelyn, mistaking her for his long-lost love, Anck-su-namun. As the mummy's lips make contact, a gruesome on-screen transformation occurs in which the entire lower portion of his face, from his lips back to his ear, reverts to its earlier state and remains that way through several scenes. "Greg Killmaster was the TD in charge of developing the look of that transition," remarked Bauer, "and Julija Learie did the animation. Besides having to 3-D match-move the computer generated partial face to the plate, we had to animate different layers of geometry peeling back to achieve a transformational look. One was a skin layer that matched the actor's. Under that was a decrepit skin layer, then a flesh layer, and inside of that, a bone layer. We used a combination of shader techniques for the 3-D reveal and exposed each particular layer in a timed sequence." Once again, lighting the see-through layers required substantial finessing. "Greg and David Deuber made certain the lighting was such that it not only matched the lighting on the real head, but also illuminated the inside of the mouth so that when Imhotep turns his head you see through the skin, through the flesh, into the jaw and bone and teeth areas."

While the mummy occupied center stage, both in Sommers' script and at ILM, key aspects of the story- brimming with thrill-a-minute action sequences- provided a colorful canvas for numerous other visual effects. When rough cuts of the Morocco shoot first made their way to him, Berton had been awed by the visually striking nature of the footage. Exterior action scenes at Hamunaptra were shot on the western edge of the Sahara at the site of a Portuguese fort, built nearly four centuries ago in the crater of an extinct volcano. For the purposes of the film, the remarkable site had been dressed with obelisks, statues, columns and ancient Egyptian architectural ruins by production designer Allan Cameron and his crew. "The Morocco stuff came back looking tremendous," said Berton, "with sand blowing across the desert, camels, huge open vistas, mountains and 800-foot-tall sand dunes. That really set the standard for us. We knew the film was going to be gorgeous, and that gave us much more impetus to make sure we were bringing something to the screen that was just as powerful."

One scene that was crafted to match the immense scale and visual splendor of the location footage was a spectacular shot of ancient Thebes, seen in an opening sequence presented as backstory. A

blend of bluescreened live-action, location photography, miniatures and matte paintings, the expansive shot was conceived in the ILM art department by Alex Laurant, who based his designs on painstaking research into ancient Egyptian architecture and hieroglyphic art. The shot opens on the Universal logo, with the camera then panning down to a pyramid, executed as a matte painting by Rick Rische, past a sphinx and a temple built by Barbara Affonso's model shop team, and into a crowded plaza. "We started off with an animatic that was approved," recalled Ben Snow, who would oversee many of The Mummy's non-creature effects. "But then the shot went through some redesign when Stephen decided he wanted to get a better sense of the city's scale and beauty. So we sent the match-move we had already done for the plate over to Louis Katz in the art department. He choreographed the move, and when it was approved, passed it back to us. Then David Washburn and Pat Sweeney translated it into curves that we could plug into our motion control rig so we could shoot the miniature. The same move also went to Rick Rische, and he used it to create a digital matte painting for the background pyramids and a lot of the background city."



Making his way across the desert with the abducted Evelyn, Imhotep conjures up a sand devil that rises from the desert floor to foil a rescue attempt by O'Connell in a biplane. The turbulent storm was one of several sand-related shots designed and digitally engineered at ILM, then composited into plate photography filmed in Morocco.



The desert bursts upward as a mountain-high wall of the swirling sand rips across the landscape in the direction of the plane- a live-action stunt craft filmed on location. The advancing sandstorm, simulated in Maya and rendered with ILM's proprietary particle renderer, made use of a specially devised shader to impart a swirling, sandy look to the particles.

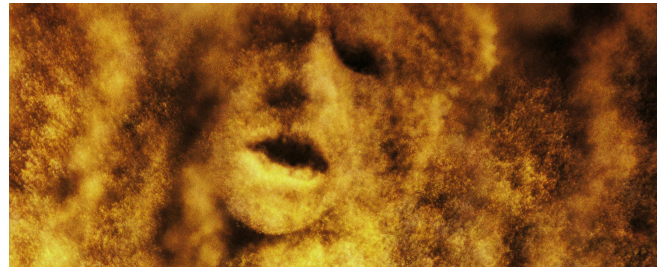
More visual spectacle was required for desert sequences revealing Imhotep's ability to control the forces of nature. In a dramatic demonstration of his powers, the mummy- who has abducted Evelyn and is attempting a return to Hamunaptra with his captive in tow- conjures up a tornado-like sandstorm to thwart a rescue attempt by O'Connell, following in a biplane. At first glance, Berton saw the sandstorm effects as a repeat of the tornado effects in Twister. Upon closer examination, however, he determined that a somewhat different approach was in order. "Here we were representing something that had more motivation," Berton observed. "This was supposed to be a magical sandstorm that Imhotep is controlling- not just a wild, random event. We still needed to capture the complexity of a real storm in order for you to believe that it was really rising off the dunes, ripping across these immense spaces and crashing over the mountain like a huge wave. But we had to put something in there that was worthy of the kind of space and epic scale that was in this incredibly vast photography captured in Morocco. And there was no way we could just take the Twister programs and pop them in."

Animators could, however, use their understanding of complicated procedural systems to manipulate the immense particle fields required for the look they sought. Guided once again by conceptual art from Laurant, Ben Snow and Mike Ludlam oversaw the work in Maya, which afforded considerable options for mixing geometry with simulations. That would come in handy for shots such as one in which a sand devil, raised by Imhotep, had to take on the shape of the mummy. "We constructed an animated Imhotep in the computer and assigned goals to it, so that the particles would be attracted," Snow related. "Amelia Chenoweth worked on that effect, creating lots of streaks of ribbony particles in the swirling sand that come closer and closer together to make it look like Imhotep is forming out of the sand." In a subsequent shot, the valley below splits apart, and cracks race across the desert floor- an effect achieved by combining a matte painting with procedural animation by Mike Ludlam.

As the roiling sand sweeps across the valley- an effect created in Maya by Ludlam, and rendered with ILM's proprietary particle renderer- a massive wall of sand explodes skyward, barreling wave-like toward camera. "We'd done some work with waves in Deep Impact," said Snow, "but those were big surfaces rather than this sort of thing. This was quite different in that it needed to have a sandy texture. We ran into the problem you always do with particles- trying to get away from the look of distinct dots. One of the clever things Raul Essig came up with was a new particle render shader that created swirly streams of particles instead of little clusters that tend to look clumpy. So we ended up with a shape that exhibited these nice tendrils, which gave it a more flowing, sandy feel. Then Scott Frankel's compositing team did a lot of image processing to make it even better." Timing of the roiling wave to meet Sommers' expectations was particularly irksome. "Changing the timing is always a problem with dynamic simulations, but the director wanted the wave to go faster. The way we did it, without losing the nice rolling dynamics, was to actually render a much longer simulation, then time-compress that back to speed it up."

As it closes in on the biplane, the mountain of sand begins to form the image of Imhotep's shrieking face. For the face-in-the-sandstorm effect- digitally engineered by Joakim Arnesson, Raul Essig and Glenn Sylvester- Sylvester first animated a Vosloo head that had been digitized in the computer, taking it through a range of terrifying expressions. "From that," stated Snow,

“we generated some data that we could plug into our simulation on the one hand, and then, at render stage, use it to modify the sandstorm part so that it looked like a face was forming out of the sand.” An effective touch by Arnesson was the addition of little puffs of sand, rendered in Maya, to simulate bullets bouncing off the face as O’Connell fires at it from his plane. The scene concludes with the face engulfing the biplane and appearing to swallow it up.



As the roiling sandstorm overtakes the tiny aircraft, it assumes the terrifying shape of Imhotep’s shrieking countenance. ILM animators digitized a model of Arnold Vosloo’s head to generate data they could use in modifying the sandstorm to reflect the actor’s likeness.



Closeups of O’Connell firing a machine gun at the advancing specter from the tail of the aircraft were photographed using a plane mockup mounted in front of a bluescreen, then composited into appropriate background imagery.

A similar face-in-the-sand effect was showcased in an earlier scene, when O'Connell inadvertently stumbles upon Hamunaptra during a scuffle with a warring desert tribe. In that instance, Imhotep's screaming visage forms in the shifting sands beneath O'Connell's feet. Animators scanned Vosloo's face into the computer and then generated a height field, applying it to geometry to create the sculpted look. "David Hisanaga devised a very effective sandy texture that we used to reveal sections of this rising sand mass," commented Snow. "He set up multiple layers of textures to make it look like sand is actually

running down the sides of the face as it forms. It was interesting, because when they shot the plate the practical effects people put huge sprays of sand in there. It looked great, but when it came back to us, we said: 'Oh no! Now we not only have to create mounds of sand that look like Imhotep's face, we also have to match these huge plumes!' So Marshall Krasser, one of our compositors, cleverly took bits of the existing plumes and repositioned them in a totally seamless way. Also, at several points in the scene where Brendan falls without any real motivation for it, Marshall did some terrific 2-D work to reposition the existing sand hits and make it look as if they were really blasting him off his feet."

Besides digital sand manipulation, effects of a more horrific nature were mandated for scenes in which expedition members are pursued by hordes of flesh-eating scarab beetles released from Imhotep's sarcophagus. Thousands of the scuttling insects were computer generated at ILM with the help of a new RenderMan feature called RIB Archive that allowed the digital team to more efficiently render large amounts of geometry. "Cristophe Hery and Hiromi Ono originally developed it for *The Phantom Menace*," said Snow. "Sequence supervisor Ed Kramer and tech director Erik Krumrey then took some of their work and built on it to get our scarabs to orient correctly to whatever surface we had them swarming over. Glenn Sylvester created a sort of 'scuttle' animation cycle, and we'd simulate all these scarab particles in Maya going along the ground or up a ramp or over the body of a character who falls down and is engulfed by them. Then, using some of this RIB Archive and the pipeline we set up to exploit it, we put all these complex scarabs on top of them. So that ended up working quite efficiently. It also meant we could do a rough animatic on the whole sequence and get buy-offs on the positioning of all our scarabs before we did our beauty renders." Kramer also devised a light-scattering shader for the scarabs that lent a sense of iridescence to the insects by simulating an oil-on-water type look.

In addition to the horrific scarab invasion, Imhotep's awakening brings with it the ten plagues of ancient Egypt, revisited upon the ill-fated members of the expedition and upon inhabitants of Cairo. Using Maya particle simulation, David Horsley rendered swarms of locusts descending upon the archaeologists' desert campsite in the first of such occurrences. "Interestingly, some of the best reference David found for the locusts was the 1937 film *The Good Earth*," Snow



Computer graphics supervisor Ben Snow oversaw many of the production's non-creature effects.

commented. "It contained some amazing work done with a cloud tank. We wanted to get that distinctive look of a swarming, roiling column of locusts, so David created an attracter field for the particle simulation, which provides hero particles you can animate by hand or with particular forces, and everything else swarms around them. Then he applied layers and layers of different types of turbulent motion."

Horsley replaced lower-resolution models of the locusts with detailed ones for closeups such as one in which the insects are seen inundating a victim. "Bob Powell tech-directed that shot," said Snow. "The production had shot this amazing plate of the actor covered with real anesthetized locusts, and we had to add our CG locusts alongside the real ones. They got a lot closer than we originally anticipated, but Bob did some procedural work on it, and there was additional paint work so the model would hold up better at close range. You really couldn't distinguish the difference between them."

Horsley directed another plague sequence in which CG flies spew from the shrieking mouth of Imhotep and swarm into a crowded marketplace. The shot featured Vosloo as Imhotep in an elaborate makeup prosthetic by Dudman that covered his face, neck and chest. Animators then tracked in their digital prosthetic, which enabled the jaw to overextend. For the flies, Horsley employed a technique that was similar to the particle simulation used for the locusts. "There were slight differences in that the flies needed to have a sort of oily texture," stated Snow. "But the real problem was getting the effect to match the plate photography, which had been shot in this odd day-for-night situation to simulate an eclipse that Imhotep has ostensibly conjured up. When we scan in darker shots and convert them to the digital medium, we can scan them in a bit brighter than they actually are. So in this case, we had to examine the shot a lot on film to judge whether or not the flies were going to look too shiny or metallic. Marshall Krasser was the compositor who sorted all that out."

Integrating the digital flies with the real crowds in the plate photography required elaborate match-move work by Wendy Hendrickson. "We had some rough match-move objects to represent people flailing at the flies so that we could actually render them in amongst these standing objects," explained Snow. "Then David Horsley, working again in Maya, attached a repulsion field to a standing object that represented the mummy, so the CG flies were repelled from it and would appear to part as Imhotep walked through the crowds."

Digital techniques were not the only approach used in rendering plague sequences. Nick Dudman and his makeup effects crew bore the full brunt of crowd scenes featuring hundreds of Cairo inhabitants afflicted with a plague of boils and sores. "We mass-produced prosthetic boils and sores and made up a huge crowd of extras," Dudman commented. "Our record one night was 147 makeups, which six of us managed to do in just three hours. It was much like painting the background for a scene. Fortunately, the locals- whom we used as our subjects- were very cooperative."

O'Connell's dogged attempts to rescue Evelyn culminate in a final confrontation at Hamunaptra where an army of priest and soldier mummies come to Imhotep's defense. A majority of the shots involving the reanimated mummies were filmed live with performers in suits and makeups crafted by Dudman, who was also charged with their design. "After umpteen concepts," said Dudman, "we arrived at twelve priest characters- skeletal versions of previous Universal mummy types- all green-gray bandages, with bits of rotting flesh and bones sticking out and dry powder everywhere. We obtained lifecasts from some incredibly skinny people and sculpted four or five basic body shapes that could be altered slightly. Then we constructed twelve distinct heads. It was all done with pretty standard technology. For the soldiers, though, it was totally different, because they were not in the script when we started. Stephen just turned around one day, and stated: 'Hey, I've got an idea for the final sequence to up the ante. Just when the hero has gotten rid of all those priests and thinks he has won, up come these Terminator-type super-mummies.'"

The hair-raising finale would blend live-action stunt performances by men in mummy suits with twenty-five shots of computer generated substitutes for scenes in which sword-wielding mummies are dispatched by O'Connell. "It's absolute mayhem," observed Snow. "O'Connell lights into them with a sword, and essentially guys are getting chopped into pieces and heads are chopped off. But all the body parts keep moving. It's not the sort of thing you could do with people in suits." The sequence had echoes of Ray Harryhausen's sword-wielding skeletons in



In a no-holds-barred final battle sequence, O'Connell grapples with an Imhotep emissary, one of an army of automaton-like priest and soldier mummies summoned by the high priest, who burst through the temple floor from their entombment chambers below. The more traditional-looking mummies were executed primarily with stunt performers in full-body suits designed and fabricated by Nick Dudman. For shots of O'Connell dismembering and dispatching his adversaries in graphic fashion, the stunt performers were digitally augmented by computer generated mummies created at ILM and tracked into the live-action footage. As with the early-stage mummy shots, digital performances incorporated into the carefully choreographed battle scenes benefited from motion capture sessions conducted at Shepperton.

Jason and the Argonauts, and the digital team looked to that watershed achievement in visual effects for inspiration. “Obviously, we have different technology for doing battles like that with amazing creatures that can’t exist in reality,” commented Berton, “but we looked at Jason and the Argonauts, and said, ‘How can we make something that’s as good, as magical or as memorable as this?’”

Although Dudman’s practical makeup designs would, in this instance, drive the digital work at ILM, consideration had to be taken at every turn for the planned CG replacements. “If we did something that presented a problem for ILM six months down the road,” Dudman remarked, “we could have doubled the cost of the original concept. So there were a lot of discussions with John and his people to make sure that they could match what we had in mind, and vice versa. We ended up with about fifteen different soldiers, much beefier characters than the priests and more evil-looking, dressed in old rotting armor. Each character required a full-body suit; plus there were versions of each suit– stunt versions, fire versions and prosthetic versions– for all the elaborate stunts that were planned.”

All of the mummy suits were sent to ILM for cyberscanning. Then digital versions were modeled so they could be added to the shots as needed. To conserve time and money, CG modelers fashioned the new characters by cannibalizing elements, such as muscle and bone structure, from the hero model of Imhotep. “We didn’t want to build forty creatures,” Doherty commented, “so we took the essential foundation elements of Imhotep and stuck them into these guys. That expedited the whole process of building a lot of different creature geometries. The biggest headache, though, was keeping the models identical so that one piece or one texture map could fit them all.”

As with Imhotep, animation of the CG mummies in the carefully choreographed battle scenes would benefit from motion capture data derived on stage at Shepperton. “We worked out all the complicated stuntwork and camera choreography on the real sets in advance,” said Berton, “then photographed all the stunt guys and Brendan going through their actions. Next we shot the background plates with just Brendan in the scenes. After that we took the stuntmen into the motion capture studio and had them repeat their actions against a stunt double who was now playing Brendan, so that we could capture their motion against the backgrounds. That way, we knew we’d have motion capture data that was going to match Brendan’s live-action photography. ”

To help visualize the scenes, animators created CG animatics for the shots, plugging the motion capture into stand-in action figures. “We had motion capture takes for just about every individual action of every mummy,” commented Turner, “so that we could plug them into the scenes and reassemble the whole thing after the fact. Fortunately, Brendan Fraser had gotten it down to the point where his timing and his movements were virtually identical, with or without the stunt guys to play off of. Because his movements were so good, places where he would stab the mummies, you almost got the sense that there was something on the end of his sword. He played it so well, it really made our job a lot easier.”

The issue of how to best vanquish Imhotep was a matter of considerable discussion throughout the production. The script had Imhotep sinking, in fine mummy tradition, slowly into a bog– an

homage to the first of the Hammer mummy films of the fifties and sixties in which Christopher Lee met a similar fate. Later, however, Sommers determined that a showier finale was needed. Fortunately, the mysterious bog, which earlier in the story had been shown to have magical properties, afforded ILM a suitable rationale for embellishing the ending.

In the new version, executed as a three-shot sequence, Imhotep staggers into the bog, which promptly reacts, roiling and bubbling as the heads of mummified priests bob to its surface. "Technical director Greg Killmaster added the animated head effects," recalled Snow. "Then he did a lot of work using Maya dynamics to try to get a bubbling, messy look to the surface of the muck. Regan McGee, the roto artist on the shot, also did some amazing roto work around Arnold, to try to keep some of the bubbles and splashes that were in the original plate."

As Imhotep sinks further into the slime, it begins to eat away at his skin and flesh, peeling away the layers to reveal the stage one mummy. "The big deal there," related Snow, "was getting the match-move correct, because we had Arnold as the character and had to match him with our CG model. Selwyn Eddy led the match-move effort on those shots. For the CG model, we used an existing reference model for the head that had been built by James Doherty's team to exactly match Vosloo's. So we ended up just scanning in his torso and building a special model to match that. Then we used a combination of viewpaint and procedural techniques to eat away the surface model and reveal our stage one mummy body underneath."

The sequence concludes with the character's head, now reduced to its original gruesome form, sinking into the bog- a scene that had to withstand closeup scrutiny. "The problem we encountered," Snow remarked, "was that our CG mummy and Arnold didn't match very well. In the first stage, Imhotep's head is nearly squashed, his eyes are out of alignment and 3000 years of decay have taken a serious toll. So transitioning from the actor to the model was not easy. We ended up having to do a lot of hand-animation to blend the two."

In the final analysis, what was most fun for John Berton and the ILM team was the opportunity to take a classic character such as the mummy and come up with a modern version so outrageous as to test the limits of believability, yet still have it be utterly convincing. "One can't help but wonder what some of the horror movie directors of the thirties and forties would have done had they been able to make creatures that looked like this, instead of settling for wrapping an actor up in gauze," John Anderson reflected. "The stuff we're doing today is nearly at the fidelity of the medium, and a director can pretty much make the creature he wants without worrying too much about the technology. As the most complex character we have ever done, Imhotep is clearly a product of that capability. He really wasn't designed based on what we thought we could make. He was designed based on what we wanted to make. Then we just figured out how to do it."

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